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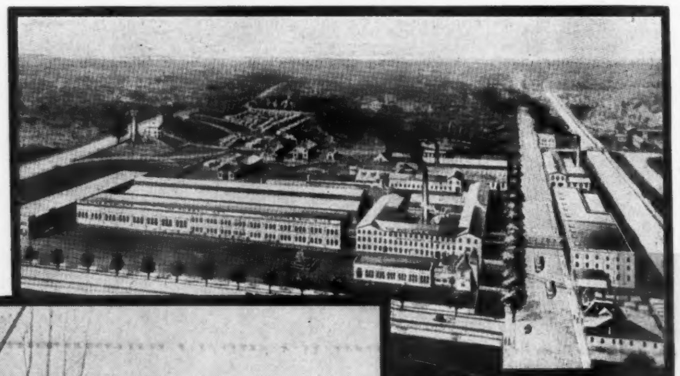

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FEATURE CONTENTS

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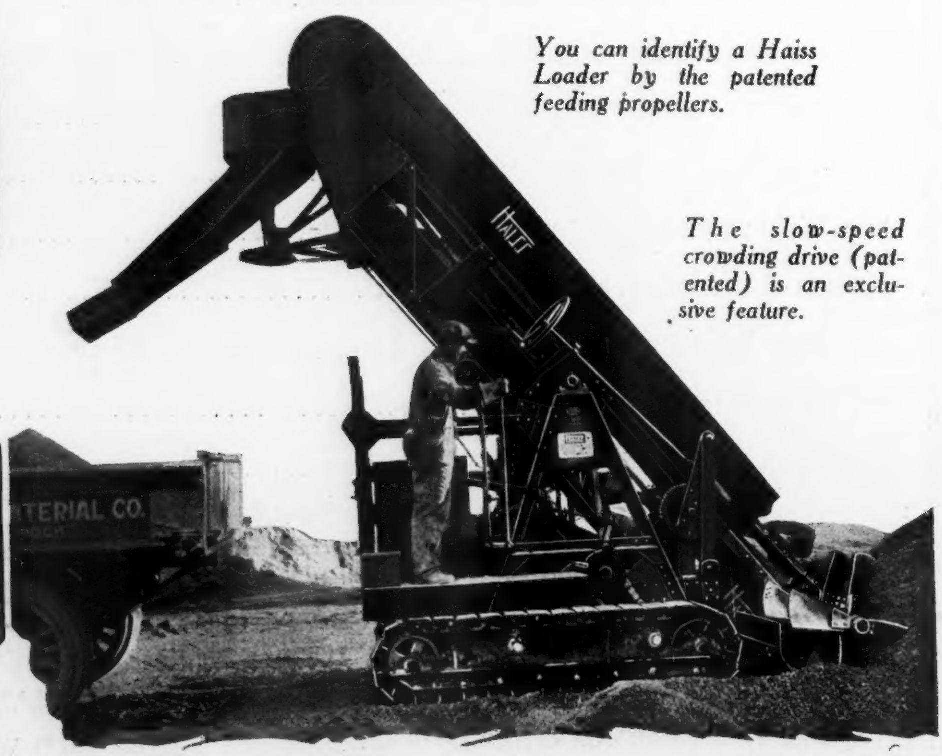

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Pit and Quarry

Vol. 13 CHICAGO, ILL., JANUARY 19, 1927 No. 8

KEEPING EMPLOYEES HEALTHY

THE spirit of an employee may be willing, but it availeth little if the flesh is weak. Individual efficiency in industry depends on the development and maintenance of sound minds in sound bodies, and many progressive firms have adopted plans for supervising the health of the personnel.

Physical examinations prior to employment are now required by several large organizations. This practice assures the selection of workers who will be physically able to keep up production and prevents the placing of men with poor vision, weak hearts, contagious diseases and other disabilities in positions where these defects may result in injury to either the worker or his fellows. From an economic as well as moral standpoint it is imperative that only able-bodied men be employed.

In addition to the initial examination, periodical inventories of the worker's health are conducted by an ever increasing number of firms. One company re-examines the important members of its personnel every six months, although in the majority of cases, annual examinations are considered sufficient. The cost of such physical examination, if the volume of work is large enough to justify a full-time physician, is estimated at something less than $1 per man. On a part-time basis, which is the usual arrangement for smaller plants, this cost is proportionately reduced.

First-aid equipment for the treatment of minor injuries is found in almost every plant. Some of the larger institutions provide individual hospitals, dental offices, and similar features, while the medium sized plant arranges for such services on the outside, retaining only a trained nurse at the first-aid station. Such arrangements and medical departments far more than pay their way by keeping employees at work. The continued production so provided naturally reflects to the profit of both employee and employer.

In the Central Manufacturing District of Chicago there has developed a unique arrangement among a group of small industrial plants whereby each is provided with medical assistance at a minimum of cost. In this group of plants a good doctor, with a leaning toward industrial practice, has established himself on a syndicate basis. His clients are the companies and each pays him a retainer's fee based on the number of men employed. In return he makes periodical visits to each shop, doing the usual work of examining teeth, eyes, throats, skin abrasions, or making physical examinations and medical recommendations either to the management or to the individual men. His office is located in the convenient center of this group of plants so that he is constantly on call by any one of them in the event of an emergency. Such an arrangement provides small plants with expert assistance at small cost, and enables the physician to keep constantly in touch with upwards of 400 men from whom can be developed a reasonable private practice. So mutually advantageous is the plan to all concerned that the companies frequently are permitted to lower the retainer fee after the first year or two, if they so desire.

Keeping employees healthy is the second phase of the problem. For this purpose recreational activities such as are developed by community clubs, athletic associations, and the like, are excellent allies. Under proper guidance these activities supply the workers with wholesome outdoor and social relaxation that tends to eliminate the oppression that is especially noticeable in plants where specialized operations require the worker to turn out the same product or part day after day, with little or no variation.

In some industries, rotation of jobs has been found advantageous. As an example, an employee whose duties cause him to be exposed to excessive heat, fumes or gases, can be detailed to perform other work that will occasionally bring him to the outdoor atmosphere. Such shifting is of course impossible in some plants.

Annual vacations are usually granted to clerical employees. Of late years this practice has been extended by many firms to include other classes of workers. One large eastern machine shop grants vacations with pay to all shop men. A large packing house gives all workers (employed continuously for one year or more) a week's vacation with pay. A large garment manufacturer advocates vacations with pay to day workers, and vacations without pay to piece workers. Several concerns award two weeks' vacation with pay to all whose attendance records have been perfect for 50 weeks. Doing everything possible to keep employees healthy is of practical value to any industry.

LESSON CONTAINED IN FIVE DAY WEEK TALK

LITTLE short of astonishing was the volume of comment—newspaper, magazine articles, editorials, and cartoons—that came as a result of Henry Ford's announcement of the establishment of the five-day-week policy. Astonishing because the five-day-week has been in active force in a number of industries for several years.

In whole or in part, the 40-hour week has been in force in the baking, laundering, printing, publishing, clothing, fur building, iron and steel, paper box-board, foundry, lumber, pottery, machine tool, coal, textile, meat packing and metal mining industries for varying periods up to four years. In some of these industries, the 40-hour week policy effects only a small fraction of the whole, but in others, such as fur workers and several branches of the clothing industry, the policy has been in active force for a long time.

We cannot convince ourselves that Mr. Ford believed he was instituting something unique when he inaugurated his 40-hour week plan. We believe, rather, he was acting entirely in his own interest and that in recognition of the publicity power of his name and his actions, and the inherent lack of memory on the part of most people, he made advertising capital of his rather simple move.

In this connection, it is interesting to compare his statement, made to Samuel Crowther and published in the *World's Work*, with the remarks of Judge Elbert H. Gary as published in the *New York Times*. This comparison follows:

Mr. Ford said:

"The country is ready for the five-day week. It is bound to come through all industry. In adopting it ourselves, we are putting it into effect in about 50 industries, for we are coal miners, iron miners, lumbermen, etc. The short week is bound to come, because without it the country will not be able to absorb its own production and stay prosperous. . . . The industry of this country could not long exist if factories generally went back to the 10-hour day, because the people would not have time to consume the goods produced. For instance, a workman would have little use for an automobile if he had to be in the shops from dawn until dusk. And that would react in countless directions; for the automobile, by enabling people to get about quickly and easily, gives them a chance to find out what is going on in the world—which leads them to a larger life that requires more food, more and better goods, more books, more music—more of everything."

Judge Gary said:

"I do not think the workers would favor it unless they should receive the same compensation for the five-day week that they now receive for six days, and that the employer can't afford to pay. The employer would have to carry the added expense to the consumer, and the consumer wouldn't stand for it, and ought not to be made to. . . . It is illogical to work only five days a week and get paid for six. Most people work six days, and it isn't fair for half of the community to work only five days and the other half six days. The commandment says: 'Six days shalt though labor and do all thy work.' The reason it didn't say seven days is that the seventh is a day of rest and that's enough."

The fact that Ford was accorded such a tremendous volume of publicity on a policy already old in several industries should teach industrialists more than a knowledge of the cash value of physical size and fame. It should bring home to them the realization that whatever the public doesn't know, regardless of how old it may be, is news.

JOHN J. SLOAN

PRODUCERS throughout the pit and quarry industries will join in sorrow over the death of John J. Sloan, who passed away on Wednesday, January 5, 1927. Mr. Sloan had been ill for several months largely as a result of overwork in connection with his duties as a member of the city administration of Chicago as President of the Board of Local Improvements. The cause of death was empyema, an inflammation of the pleural cavity. Mr. Sloan was operated on two months ago as a result of a nervous breakdown.

John J. Sloan was a Chicago product. He was born on the West Side of Chicago fifty-nine years ago. In 1884 he was graduated from St. Patrick's Academy with high honors. He attended the Armour Institute of Technology and specialized in engineering construction.

His first position was a clerkship in the city Water Department. Later he was transferred to the Street Department and he served as chief clerk from 1892 to 1895. In 1895 he went to Idaho to engage in gold mining. He returned to Chicago in 1899 and affiliated himself with a Mr. Harrison, who later became mayor. Mr. Harrison upon assuming office as mayor of Chicago appointed Mr. Sloan superintendent of the Bridewell. The record made by Mr. Sloan in administrating his office at the Bridewell is known to many officials throughout the Middle West.

In 1905 Mr. Sloan left public service to become associated with the Wisconsin Granite Company as general manager. This company grew rapidly under Mr. Sloan's influence and at the time of his death Mr. Sloan owned thirty per cent of the stock.

The crushed stone industry has profited by the judgment and cooperation of Mr. Sloan for many years. During 1924 he served as President of the National Crushed Stone Association and was largely responsible for initiating some of the constructive policies which have been a decided factor in building this association to its present strength.

PLANT FACILITIES UTILIZED TO ADVANTAGE BY ATLAS SAND AND GRAVEL COMPANY

By F. A. Westbrook

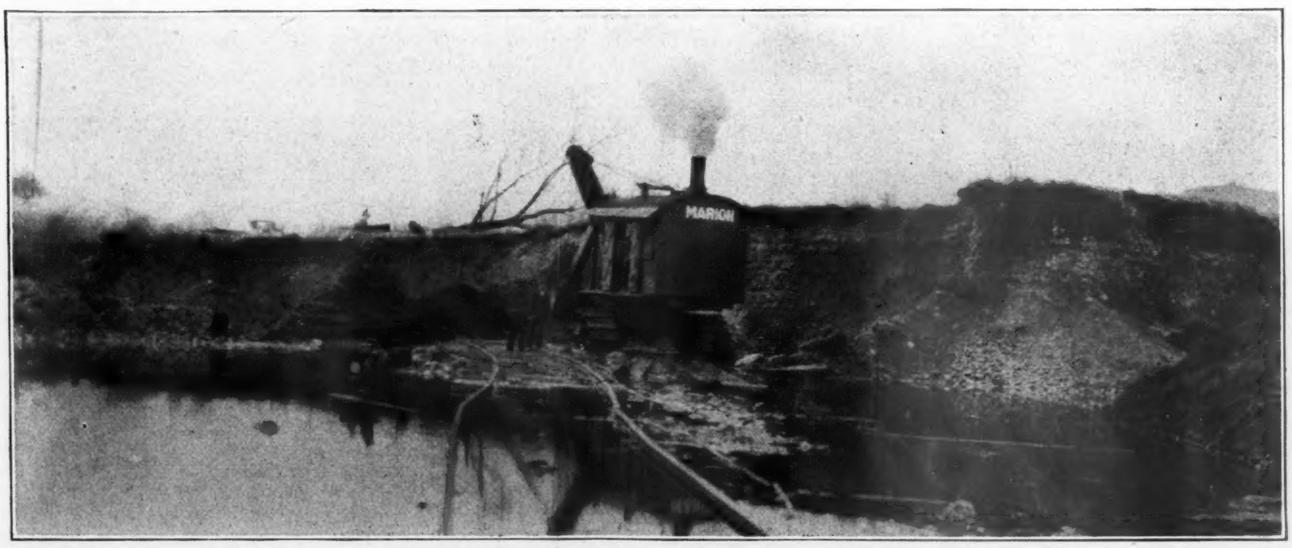
WHEN it comes to completeness, the Atlas Sand and Gravel Company, of Hartford, Connecticut, has a most interesting series of operations. Before considering them in detail it will be helpful to sketch briefly what these operations are and how they are related. In the first place, the main office is in Hartford. There is a sand and gravel bank just west of Farmington, where the bulk of the material is sand, and where sand and sand-lime brick are produced. About a mile from this plant, and connected with it by the company's own tracks, is a sand and gravel operation where both of these commodities are produced. Both plants are connected by a spur track with the trolley line between Hartford and Unionville. The nearer plant is about fifteen miles from Hartford. Practically all the sand and gravel is shipped by trolley in special cars to the storage and distributing yard in the latter city, except such as is sold locally, which varies in amount from time to time. Distribution from the yard in Hartford is made by motor trucks.

With this birdseye view of the general plan of operations it will not be difficult to follow the details of what is being done at each point and to comprehend their importance from a management viewpoint. Naturally there is a great deal of equipment; labor saving machinery has been used to a remarkable extent and, as we shall see, in rather interesting combinations.

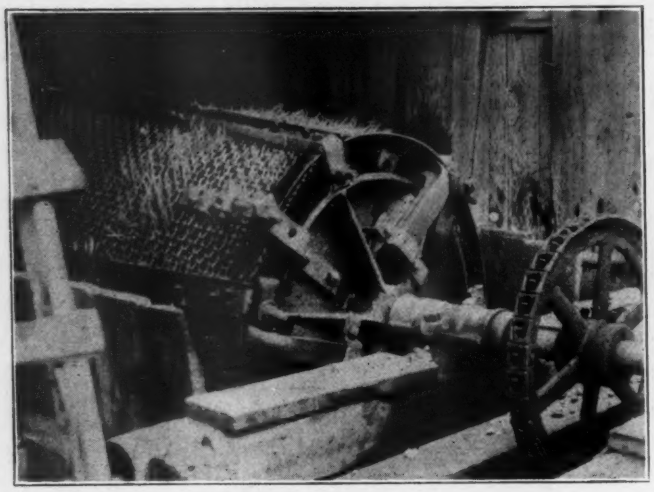
The logical point to start the detailed description seems to be at the sand bank which is associated with the sand-lime brick plant. The sand is excavated by a three-quarter yard drag line scraper, designed by Mr. Tyrrell, the superintendent. It is of an unusual design, as it has no bottom and both sides are exactly alike. In other words it works as well with one side up as the other. Naturally this is a great advantage as it is not necessary to exercise any care to keep the scraper right side up, and it may even stand on edge while being pulled along a groove or side hill. Also, it empties itself immediately as soon as the pull is reversed on an up grade, level or down grade. This construction makes for light weight so that it may be tossed easily and it makes no difference if the bucket should turn over.

Conveyor to Screening Plant Emerging from Tunnel

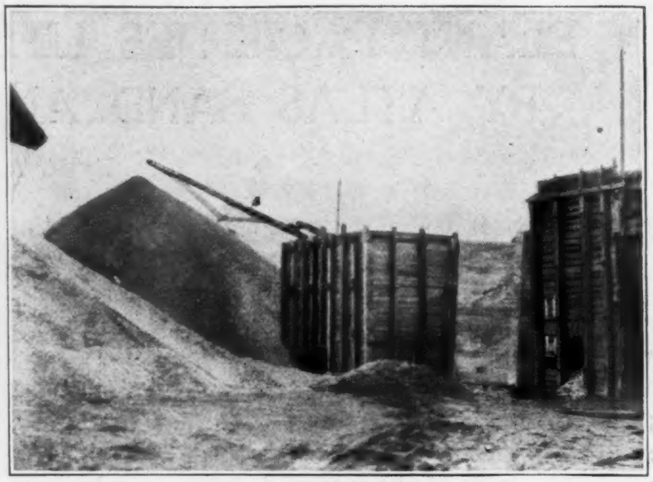
The drag line is operated by a Lambert hoist, driven by a 35 horse power motor, using Roebling wire rope. The three-quarter yard scraper is, however, not large enough for the production requirements so it is being replaced by a three yard scraper, of similar design to the smaller scraper. A two-speed Flory hoist to operate this new scraper has already been delivered which will be driven by a 100 horse power General Electric motor.



Excavating the Bank at the Second Operation with a Steam Shovel.



One of the Screens



Portable Conveyors for Storage Piles and Bins

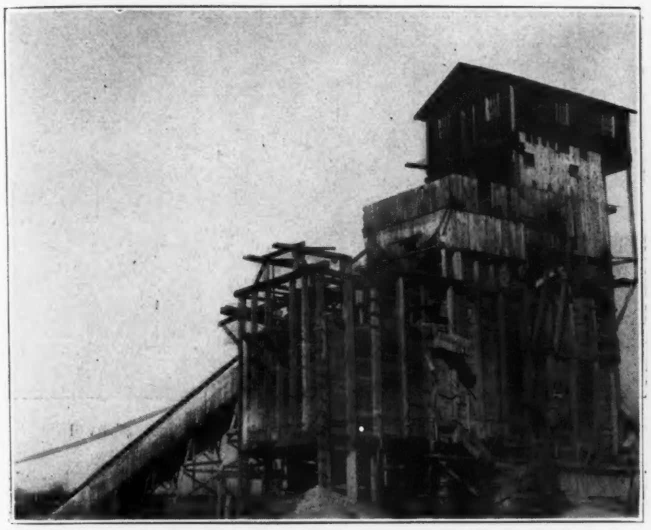
Sand and gravel, which is about 98 per cent sand, is delivered by the scraper over a 50-foot tunnel with gates every three feet. In this tunnel is a 30-inch belt conveyor, 250 feet between centers, which takes the material across the road to the screening plant. At this plant is a Good Roads Machinery Company revolving screen by means of which two grades of sand are produced, which are stored in bins. The gravel which is removed is taken to the other sand and gravel plant by the company's own cars, being hauled with a 20-ton Vulcan steam locomotive and the sand is used in the adjacent sand-lime brick plant. However, all the sand is not used for this purpose; about 75 per cent of it is taken by trolley, which has an extension to this point, to the storage and distributing yard in Hartford. The production is now about 300 tons per day with three men but this will no doubt be doubled without any increase in personnel when the new three-yard scraper is operating.

Sand-Lime Brick Plant

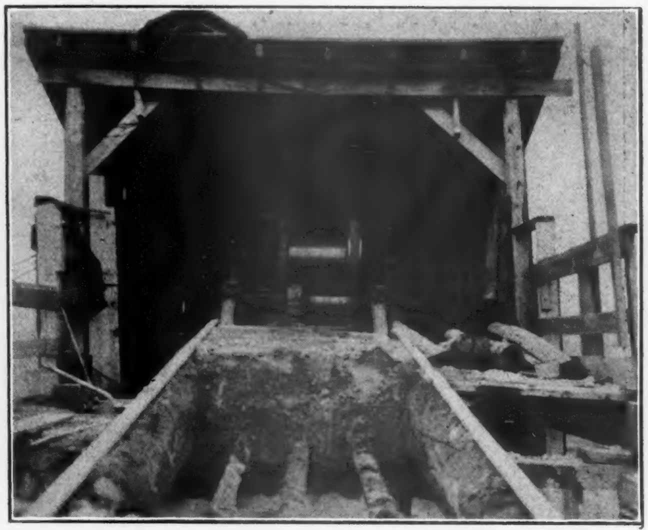
The sand-lime brick plant is well equipped with machinery and is laid out with a view to saving labor. There is a spur from the Northampton division of the New Haven R. R. which passes nearby. Lime is purchased in bulk from the Pittsfield Lime and Stone Company, near Pittsfield, Mass., and is delivered direct to the hydrating house over a spur track which is alongside the building. As the lime is unloaded from the box cars by a Barber-Greene portable belt conveyor it is dumped directly into a Sturtevant rotary fine crusher. It is then taken in an elevator up to a Jackson and Church hydrator. The hydrated lime drops into a brick bin where it is allowed to season for 24 hours.

After seasoning, the lime is again taken up in the same elevator, used for the crushed lime, to a

Screening Plant at Right with Sand Conveyor to Brick Plant at Left



View of Screening Plant Showing Conveyor from Grizzlies and Crusher



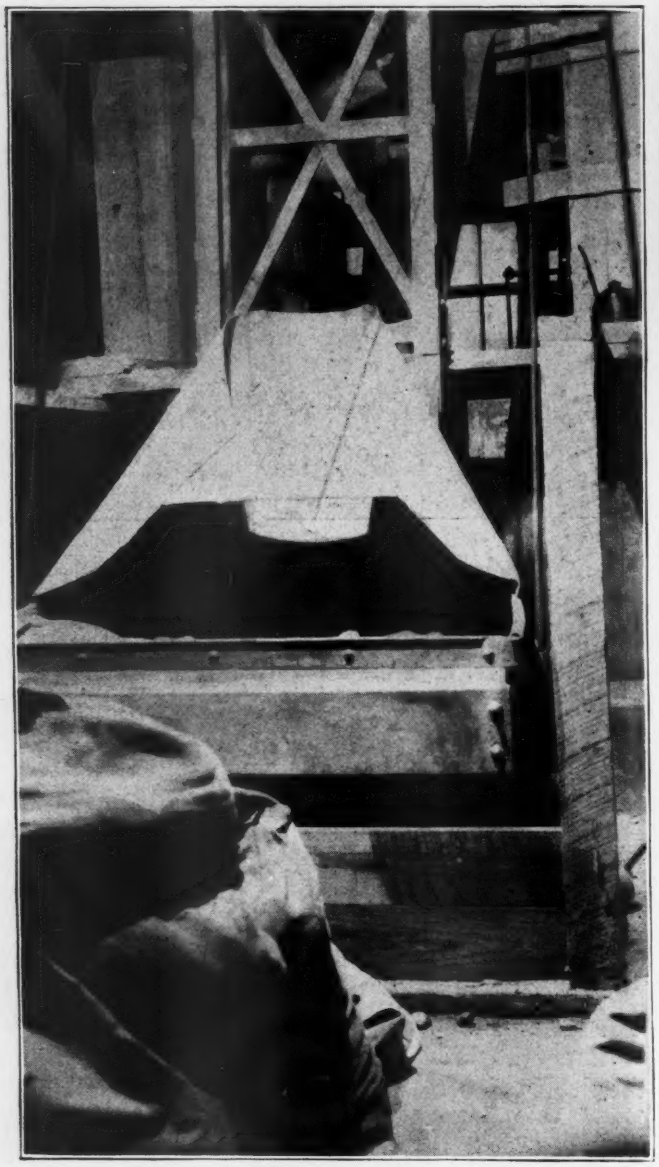
Hoist at Top of Incline

belt conveyor which discharges into a compartment in the Volumeter. Sand is brought from the storage bins of the sand plant on a 14-inch belt conveyor and discharged into two of the Volumeter compartments. After mixing, the material drops into a Jackson and Church rod mill and from there it is elevated to an American Clay Machinery Company scraper conveyor which passes across the top of three steel bins and drops the mix into any of them as desired. These bins were installed by the American Clay Machinery Company, as were also all the steel bins in the plant. The elevators were supplied by Link-Belt Company.

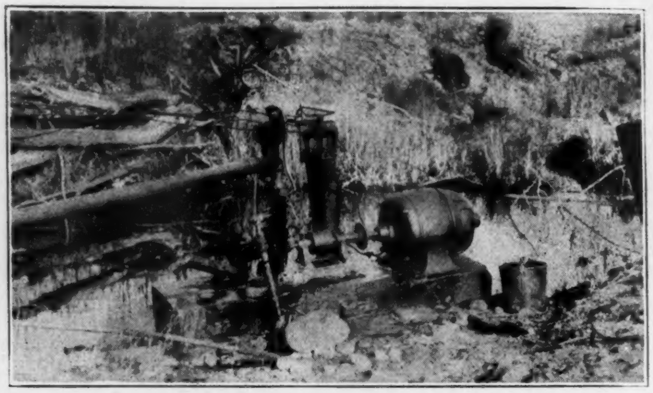
From the bottom of these storage bins is a conveyor to another elevator which discharges into a high steel bin. This bin is used to feed the brick bins by means of a Robins conveyor which passes from under it to chutes leading to three brick presses. There are two rotary and one Model C upright American Clay Machinery Company presses. Mr. Tyrrell said that the latter press works best when the mixture of sand and lime is not too wet. This department has also two steaming kilns made by the same company and a Mead-Morrison car puller to move the loaded cars in and out of the kilns. This car puller is rather an unusual feature but its usefulness has been found to fully justify its cost, in fact, it has been a very profitable investment. The brick trucks used here were made by the American Clay Machinery Company and have cast iron tops with roller bearing axles and hold one thousand bricks each.

After the bricks have been cured in the kilns they are taken on the trucks into a storage shed. Some of the bricks are shipped by railroad but most of them are loaded direct into demountable

Hartford Yard. Unloading Point in Background and Portable Conveyors Used to Make Piles of Surplus



Elevator to Concrete Mixer for Making Hollow Tile



Pumping Outfit to Supply Water to Steam Shovel

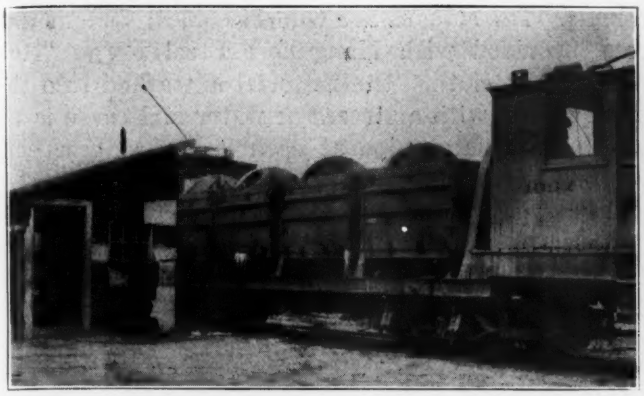
truck bodies. This use of demountable truck bodies is a great economy in several ways; it avoids several handling of the brick and it also saves time for the truck because it is a simple and expeditious means of loading. There are five of these bodies and two Federal trucks, and the bodies were made by the American Truck & Body Company.

The present output of this plant is twenty-one thousand bricks a day but by making certain changes in the plant layout it is planned to increase this to forty thousand with the same machinery. Sixteen men are now employed for making brick and only six more will be required to turn out the increased production.

The Repair Shop

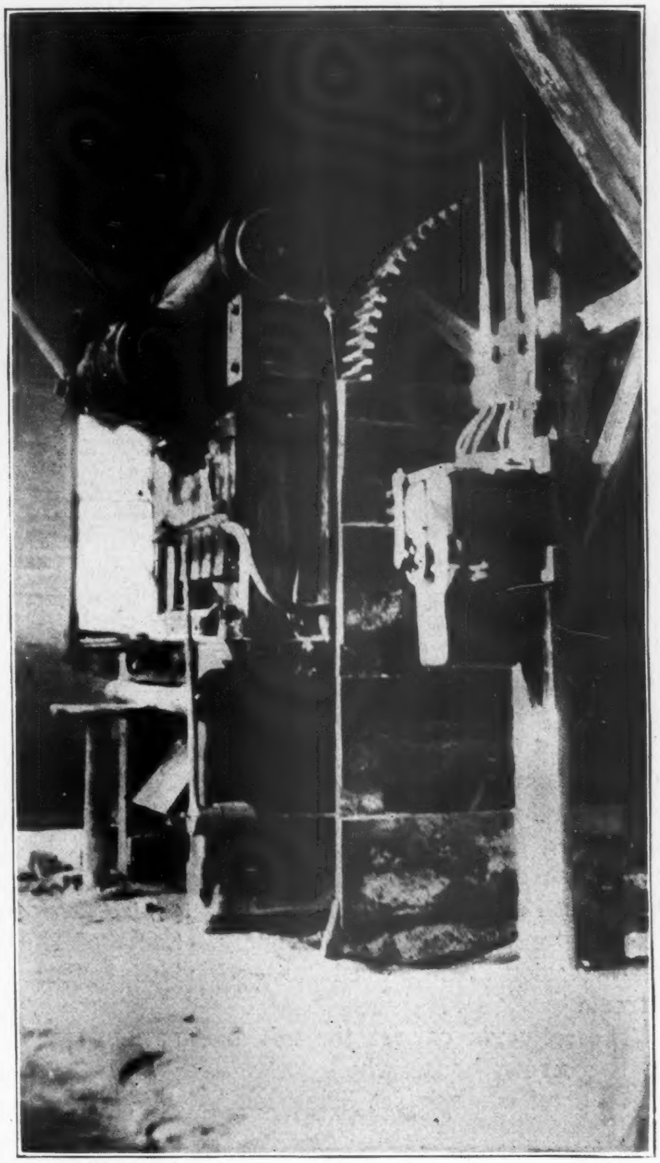
The repair shop for all of the operations is located next to the brick plant. The machinery used includes a Blaisdell drill press, Pratt & Whitney lathe and a Pratt & Whitney planer, Brown & Sharpe milling machine and a Pratt & Whitney surface grinder, the last machine being used for dressing the brick press dies. In addition to this

Detail of Drag Scraper Showing Similar Top and Bottom Construction



Specially Equipped Trolley for Transporting Sand and Gravel to Hartford Yard

there is a Champion forge and a Racine Jr. power hack saw. This machine shop is a necessity where extensive operations are being carried on, especially in view of the fact that in this locality there is no conveniently located outside shop where repairs could be quickly made. Two Bigelow boilers are used to supply steam for the brick steaming process, and there is also a preheater made by the National Pipe Bending Company.



The Upright Brick Press

Sand and Gravel Plant

The sand and gravel plant covers about 140 acres. The bank is excavated by a 1⅛-yard Marion steam shovel, Model 31. Sand and gravel are loaded directly into remodeled Western bottom dump cars, holding fifteen yards, which are hauled to the plant by the same twenty-ton Vulcan locomotive used to haul gravel from the sand plant. This plant has a rather interesting pump installation. It is used to supply water to the shovel and consists of a 1½-inch by 2-inch direct-connected Goulds centrifugal pump. This pump runs all winter but is, of course, drained at night in very cold weather.

The loaded cars are dropped by the locomotive at the foot of the incline leading to the grizzly and crusher. A Thomas hoist is then used to pull up the cars to the grizzly and crusher. The loads are dumped into a hopper, which has a big bar grizzly over the top to take out the boulders. Under the

Loaded Car Being Pulled up Incline to Grizzly and Crusher

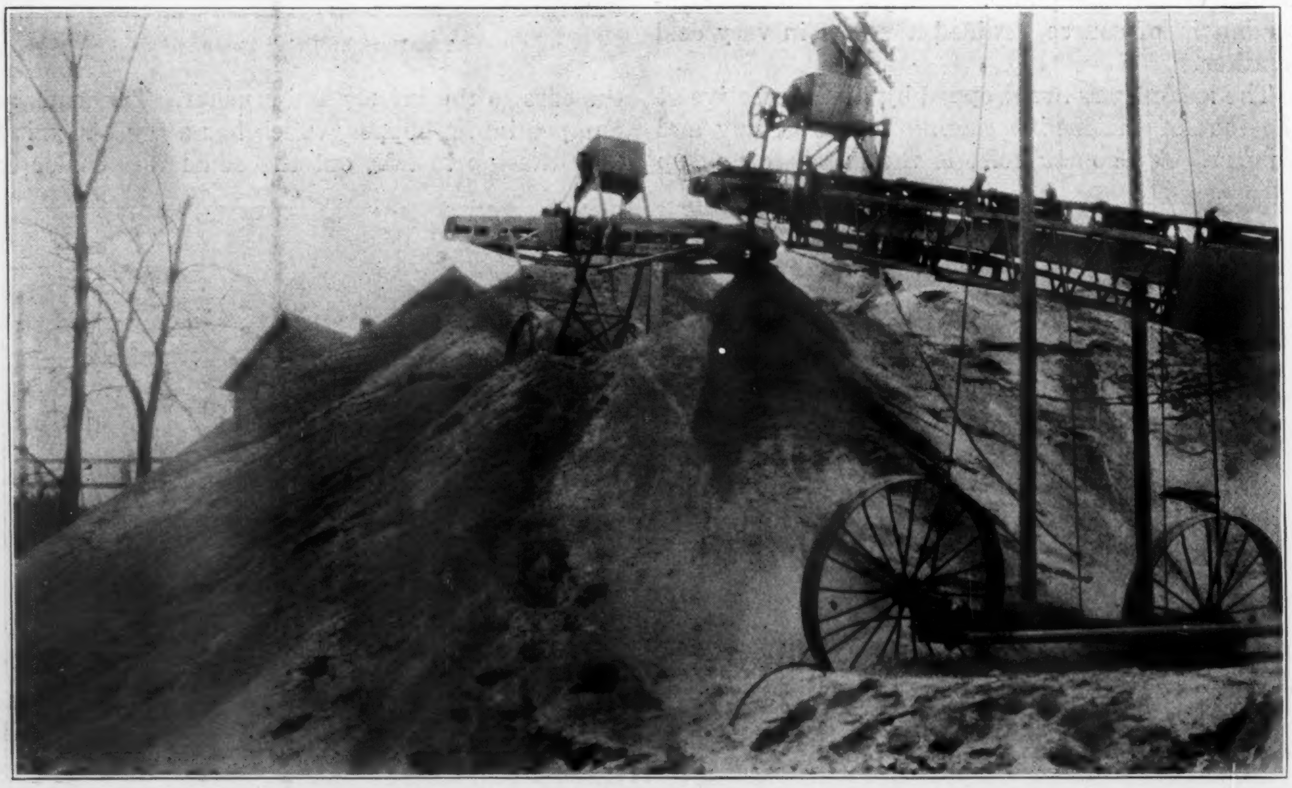
Tile Presses with Rope Conveyor Between Them

hopper is an opening feeding a two-way chute the bottom of which has a grizzly in each chute. The sand and gravel, of commercial sizes, passes through the grizzlies and the stone falls into two Number 6 Champion jaw crushers, one at the end of each chute. The crushed stone and the sand and gravel which have passed through the grizzlies drop to a 36-inch conveyor which is 320 feet between centers. All the conveyor idlers in this plant have been supplied by Robins and all the belts by the Boston Woven Hose Company. Some of the transmission belts used are Goodyear "Blue Streak."

The conveyor carries the mixed stone and sand to the screen house where there are two sets of three screens, each set being located on different levels. The screens are Gilbert conical screens and are provided with Manganese Steel Forge "Rolman" wire cloth. The material is washed into the first screen with a stream of water and there is an additional water pipe at each subsequent screen.

Screening operations are arranged as follows for each of the two sets: Top level, one jacket which sorts out the rejects and 1½-inch sizes; middle level, two jackets which produce the 1-inch and ¾-inch sizes; bottom level, two jackets which separate the ½-inch and ¼-inch sizes and sand. Three settling tanks are used for the sand which is divided into two grades. The finest grade is floated off the top of the first tank and caught in the other two tanks, which are situated at a lower level. Each grade is deposited in its proper storage bin except the oversizes from the first screen. These oversizes are discharged onto a 36-inch conveyor, 190 feet between centers, which returns them to the jaw crushers previously mentioned.

Most of the shipments from this plant are by means of trolley and the storage bins have been so constructed that the cars may be run under them for loading. Nine of these trolley cars, belonging to the trolley company, are engaged in transporting sand and gravel to the distributing yard in Hartford, and some of these cars are equipped with three boxes and others with four boxes. Each box holds eight tons and are emptied by side dumping. It is estimated that these cars do the work of at least twenty trucks and save a considerable investment as well as wear and tear on the roads. Under the particular conditions existing here the operating expense of using the electric railway cars



Close Up of Portable Conveyors on Storage Piles is less than that of using trucks. At certain times there are accumulations of surplus material and to meet the sales for local consumption the sand and gravel is taken away in trucks. These are loaded by a Monighan walking gasoline crane which is also used to make the piles of surplus material.

Hartford Distributing Yard

The Hartford distributing yard is situated on the edge of the city. Material is brought from the pits in Farmington by trolley and dumped from a higher elevation than that of the yard. The different grades of sand and gravel are kept separate but it is necessary to make the large storage piles at a distance from the dumping point because it is hardly practicable to build a trestle here from which the trolleys could dump directly on to such piles. The way in which a flexible method of mechanical handling has been devised at this yard for the making of storage piles is very ingenious and is worth noting.

The machinery which is used for this purpose consists of five Barber-Greene portable conveyors and four scoop conveyors, the latter made by the Portable Machinery Company. The conveyors are particularly convenient for placing material at the top of the pile. It is not at all uncommon to see three or four of these portable conveyors in line, not necessarily a straight line, moving material from the trolley dumps to the top of a high pile some distance away. In fact, if this kind of machinery were not available a storage yard such as this would be impossible as the expense of handling the twenty thousand tons of stored material

Unloading Brick Trucks Directly Into Demountable Truck Bodies

in any other way would be prohibitive. These storage piles are at their maximum size in the late autumn so as to have a good supply on hand for winter use when transportation is sometimes badly interrupted with heavy snow storms. These portable conveyors can be used in many ways which only seem to be limited by the fertility of the superintendent's brain. Mr. Barnes, who is in charge of the operations at the Hartford yard, told, for instance, how he had used them for pouring the concrete foundations for various structures which have been erected.

Local distribution to customers is made by eleven motor trucks. This fleet includes Macks, Sterlings and Federals, all of which being equipped with Wood hoists. Here automatic machinery is also used for loading, this yard using three Barber-

Walking Crane Used for Loading Trucks and Making Piles of Surplus

Locomotive and dump car on track to plant

Greene loaders and the record has been made of loading 110 six to seven ton trucks in nine hours with one of these machines. The yard has some bins which are filled by the portable conveyors but, naturally, bins for the entire storage capacity of the yard is out of the question, and when such efficient mechanical loading devices are available it is not worth while to invest much money in bin construction.

Tile Plant

There seems to be few uses for sand in which this enterprising company is not interested. This is shown by the fact that this company has a sand-cement hollow tile plant in one corner of the yard. The machinery is, of course, located in a building. Piles of sand and fine gravel of the proper size are made at the door, and bags of cement are brought in on a portable scoop belt conveyor, as is also the sand and gravel. Materials in the proper proportions are then dumped into a Jaeger elevator and are taken up to a Jaeger concrete mixer, at the top of the building, where the water is added. A Jaeger bag cleaner is at the bottom of the elevator which Mr. Barnes says saves about two and a half bags of cement for every hundred bags cleaned.

From the mixer the material goes to two Anchor presses. The two sizes of tile generally made here are 5 x 12 x 4 inches and 5 x 12 x 8 inches. One man at a machine turns out about five thousand

Storage for tile. Note cable conveyor with steam pipes below for curing

tiles a day of nine hours. The usual crew consists of one man at each press, three men to take the tiles from the molds and one man at the mixer. The molded tiles are placed on a cable conveyor, passing between the two presses, and carried out into the yard. So far the curing has been done by piling the tiles in close proximity to steam pipes, having frequent steam outlets, and covering the pipes and the tiles with tarpaulins. The steam is then turned on which circulates around under the tarpaulin sufficiently to cure the cement, sand and gravel mixture. This, of course, is a temporary medium and steam kilns are to be installed during the coming year.

The cable conveyor is also used for loading the trucks which stand at the far end of the building. In this way it is possible to save considerable handling but when a surplus occurs the piles are made nearer to the end of the conveyor and as close to the loading space as possible so that the tiles may be later placed on trucks with a minimum expenditure of energy. These tiles are made either smooth on all sides or corrugated on one or two sides. When one side is corrugated this side faces the inside of the building and makes the use of plastering lath unnecessary.

The combinations of operations carried on by this company seem to fit in very well with each other and while the exact details must always be largely determined by local conditions, the idea is suggestive of how sand and gravel producers may, if need be, increase their profits by adding other manufacturing processes to their basic activity.

Arbitration Campaign Started

The American Arbitration Association launched its campaign to put peace and economy, through arbitration, into every branch of trade in the United States, at a luncheon at the Bankers' Club, 120 Broadway, January 12, 1927.

More than 200 trade vice-chairmen of the association attended and endorsed the views expressed by Lucius R. Eastman, president of the Merchants' Association of New York, and chairman of the American Arbitration Association's board of directors, who delivered the principal address. Mr. Eastman explained the purposes and aims of the association and outlined the duties of the vice-chairman as liaison officer connecting the arbitral activities of 126 national, state and local trade bodies with the association.

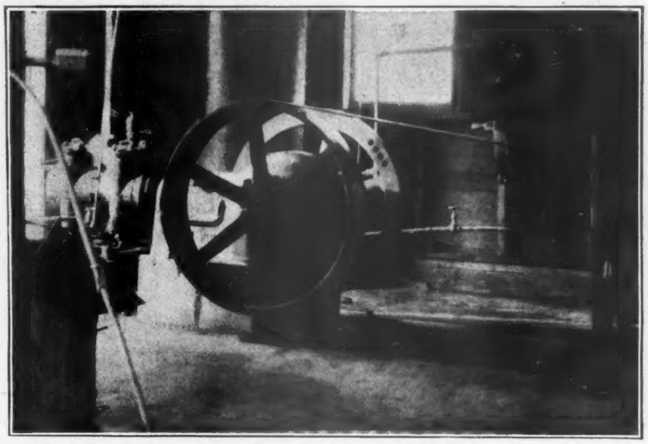
The luncheon was a New Year's celebration of good will and peace in American business relations. More than 430 leaders in trade, representing various branches of industry, have enlisted as vice-chairmen to work for the preservation of this spirit of amity through the development and improvement of facilities for the settlement of disputes within the trades by the trades.

PITTSFIELD LIME AND STONE COMPANY IMPROVES PLANT EFFICIENCY

By F. A. Westbrook

OPERATIONS of the Pittsfield Lime and Stone Company of Richmond, Massachusetts, consist of two departments. One of these produces agricultural ground lime stone, pulverized material for use in manufacturing rubber compounds, comparatively coarse material for making cement blocks and still coarser chicken grit, and the other department produces burned lime.

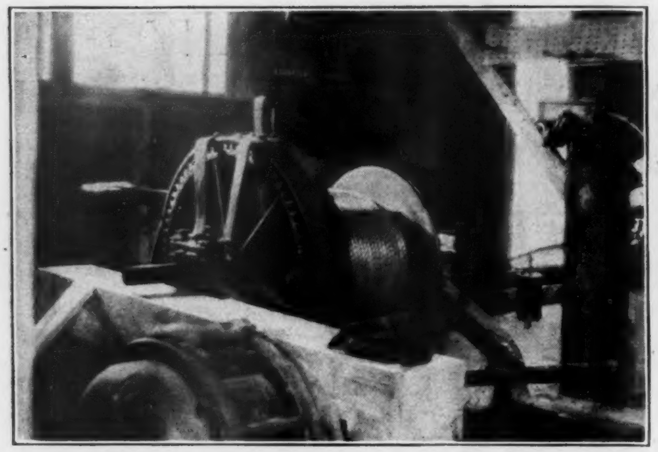
That there should be two such departments is of interest because it shows very clearly that much of the stone which is not suitable for burning can be put through other processes and made into valuable commercial products, thus avoiding much waste. It is very significant that so much is being done along these lines at the present time.



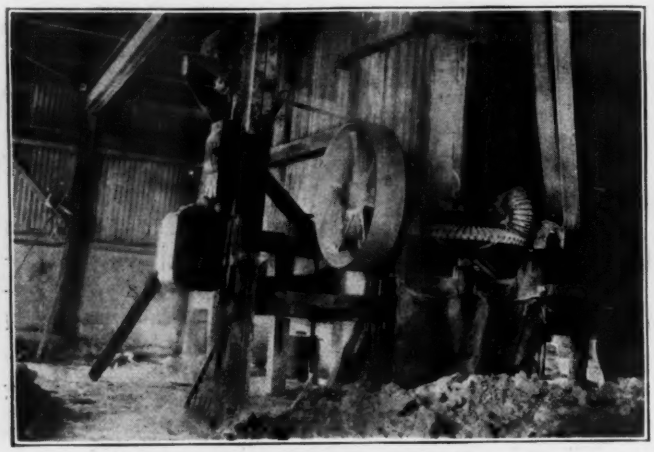
Compressor with Cooling Tank at Right Which Consists of a Metal Dump Car Body

We will first consider the manufacture of unburned limestone products. The raw material is brought from the quarry in cars and dumped off an embankment into a 15 x 19 inch Farrel jaw crusher. From the bottom of the crusher it is raised by an elevator to a bin from which it drops into a number 2, Model E, Day hammer mill. From here it is again raised by an elevator to another bin. In the spout from this bin to the Munson buhr mill is a fine wire mesh screen which permits

View of Upper and Lower Deposits



Hoist at the New Quarry. Note the Enclosed Chain Drive and Tally Board in the Upper Right Hand Corner



Lime Grinder, Showing Motor Control Equipment

the pulverized, powdery material to pass through. This reduces the amount which would otherwise have to be handled by the buhr mill and thus increases its production. The fineness to which this mill grinds is dependent on the adjustments made for the production for any particular use, and the size of the openings of the wire mesh screen in the spout may be varied accordingly. From the buhr mill the pulverized stone is taken by a third elevator to a bin from which it is bagged. Sagamore belts are used, in part, for the motor drives of this machinery.

Chutes are provided for all the bins so that various sizes of stone may be secured for a number of different purposes, including road work. The production of this department is from thirty to thirty-five tons per day.

Kiln House

At the present time there are four kilns in operation and two more are being erected. These latter are to be of steel construction designed by R. K. Meade and Company and are being manufactured by the New York Central Iron Works. A Jaeger

View of Plant Showing Kilns

View in the New Quarry

portable concrete mixer is being used for the foundation work. A Clyde hydrating plant will probably be added as soon as the new kilns are ready for use.

A Masser crusher or grinder has been installed to reduce the burned lime which would otherwise be unsuitable for commercial purposes. The lime is dumped into the grinder from the drawing floor

A Portion of the Deposit

Buhr Mill and Bagging Spout

and is afterwards conveyed to an overhead bin by an elevator, the buckets, chains and sprockets for which were supplied by the Rex Conveyor Company. At the present time ground lime is drawn directly from the storage bins for packing. Later, however, this equipment will be associated with the hydrating plant. Different grades of stone are placed in separate kilns to facilitate subsequent handling when securing material for this process. Thus it can be seen that a decided effort is being made to eliminate waste in every department.

An inclined trestle leads to the top of the kilns and the loaded cars are hauled by means of a Mundy hoist which has been remodeled for electrical operation and is located on the firing level of the kiln house.

The kilns are coal fired and the arrangements for the delivery of coal to the firing floor are somewhat unusual. Coal is delivered in freight cars brought in over a siding from the main line of the Boston and Albany Railroad. The coal is dumped into a pit, back of the kiln house, at a point corresponding to the middle of the firing floor and is then raised by an elevator from this pit to a bin. From the bin, chutes diverge to convenient points on the firing floor so that manual handling is reduced to a minimum.

Additional forced draft for the kilns is obtained by the use of Wickes Machine Company slow speed blowers, one unit for two kilns, the hot gases being burned with cold air and greatly increasing the production. Before leaving this part of the operation it should be noted that there is another railroad siding, alongside the kiln house, which enables the saving of labor during shipments. The average production per day is about 300 barrels with the four existing kilns which will be increased to 500 barrels when the two new larger kilns have been completed.

Quarry Operation

A new pure calcium stone quarry has recently been opened at this plant. The stone in the old quarry, worked for more than 100 years, is slightly high in magnesia for use as quick slaking finishing lime, but will be used in connection with the new quarry when the hydrator has been installed. The new quarry is less than a half mile from the kilns. The stone is transported from the quarry to the kilns in dump cars hauled by a Fordson tractor equipped with flanged wheels.

The opening in the quarry is being made at two points which will be joined as the quarrying operation progresses. One of these openings is already quite deep so that the cars have to be hauled up the incline by a Lidgerwood hoist. This hoist was formerly steam driven but has been stripped and an electric drive with a Link-Belt chain applied. Red stand wire rope is used on the hoist.

The hoister house is rather an interesting place

Tractor Locomotive Hauling Stone to Kilns on account of the ingenuity shown in some of the details. One of these is a tally board located at the hoisting engine. This is divided into five vertical sections, one for each track in the two openings. Each section is divided into two columns headed "Good" and "Bad", respectively. Each column has two vertical rows of six holes each. As each car load of stone is hauled out, the engineer advances the peg one hole in the proper column corresponding to the track where it was loaded, and in this manner keeps count of the production of each gang of workmen. Another interesting detail is in connection with the air compressor. This is an 8 x 9 inch Sullivan machine and the tank for the cooling water consists of an old dump car body which has been placed into service.

A second Fordson tractor is being used in rather an ingenious manner. Up to the present time one of the new quarry openings is so situated that it is necessary to ascend a slight incline from the hoister house to reach the opening. Consequently, the hoisting equipment is temporarily useless until the cut has been made deeper. However, the tractor, working on the ground, is used to pull the empty cars up the incline to the opening and, conversely, it is used as a brake against the loaded cars descending from the quarry to a point adjacent to the hoister house where trains are made up ready to be taken to the plant.

Empire Sand and Gravel Producers Hold Annual Meeting

The Empire State Sand and Gravel Producers held its annual meeting at the Hotel Statler, Buffalo on January 6th. There were in attendance twenty-eight producers and the meeting was one of great interest and importance to the industry.

J. E. Carroll of the J. E. Carroll Sand Company, President of the Association, in well chosen words reviewed the first year's activities of the Association and paid a fitting compliment to the members on their loyalty and active interest. John G. Carpenter of the Sand and Gravel Corporation, who is Secretary-Treasurer of the Association, presented his financial report which showed that the balance was satisfactory and also suggested a plan of activities for the year 1927.

This was followed by resolutions which expressed the appreciation of the members of the effective work of the outgoing officers, J. E. Carroll, President, G. K. Smith, Vice-President and John G. Carpenter, Secretary-Treasurer. In the remarks made at this time special mention was made of the fact that, while the Association was in its first year of existence, many important undertakings had been accomplished and already its activities had become a real force in the Empire State.

An amendment was made in the constitution to provide for the admission of firms selling sand and gravel equipment as Associate Members. A most important feature of the meeting was a general discussion which covered problems of sand and gravel production and the best methods for promoting the interest of the industry.

The following officers were elected for the ensuing year: G. K. Smith of the Albany Gravel Co., President, David Hyman of the Buffalo Gravel Co., Vice-President, John G. Carpenter, of the Madison Sand and Gravel Corp., Secretary-Treasurer. These officers and H. E. Moran of the Olean Sand and Gravel Corp. and John A. Taylor of the Valley Sand & Gravel Corp. constitute the Executive Committee.

The following producers were present:

J. E. Carroll, J. E. Carroll Sand Co., Buffalo, N. Y.
G. K. Smith, Albany Gravel Co., Albany, N. Y.
John G. Carpenter, Madison Sand and Gravel Corp., Hamilton, N. Y.
Henry F. Marsh, Consolidated Materials Corp., Buffalo, N. Y.
G. O. Spaulding, Silver Spring Sand & Gravel Co., Silver Spring, N. Y.
E. B. Foote, Consolidated Materials Co., Rochester, N. Y.
C. A. Adams, Madison Sand & Gravel Co., Madison, N. Y.
John A. Taylor, Valley Sand & Gravel Co., Rochester, N. Y.
Nathan Oaks, Nathan Oaks & Sons, Oaks Corner, N. Y.
W. J. Gilmore, Valley Sand & Gravel Co., Rochester, N. Y.
Carlton Oaks, Nathan Oaks & Sons, Oak Corner, N. Y.
Frank A. Eldridge, Eldridge & Robinson, Auburn, N. Y.
J. W. Robinson, Eldridge & Robinson, Auburn, N. Y.
L. H. Kessler, Springville Sand & Gravel Co., Springville, N. Y.
H. A. Stelley, Buffalo Gravel Co., Avon, N. Y.
W. F. Truby, Genesee Sand & Gravel Co., Buffalo, N. Y.
Willis M. Spaulding, Silver Spring Sand & Gravel Co., Silver Spring, N. Y.
D. E. Moore, Silver Spring Sand & Gravel Co., Silver Spring, N. Y.
Walter Sunderland, Sterrett Sand & Gravel Co., Springville, N. Y.
W. J. Weinand, Jr., East Aurora Sand & Gravel Co., Buffalo, N. Y.
H. E. Moran, Olean Sand & Gravel Co., Olean, N. Y.
M. P. Ryley, Clarence Supply Co., Buffalo, N. Y.
R. W. Eberly, Buffalo Gravel Corp., Buffalo, N. Y.
W. G. Shoemaker, Daigler Sand & Gravel Corp., Williamsville, N. Y.
B. M. Milson, Genesee Washed Gravel Corp., Buffalo, N. Y.
Jas. J. Pendergast, Genesee Washed Gravel Corp., Buffalo, N. Y.
David Hyman, Buffalo Gravel Corp., Buffalo, N. Y.

STATE OR CONTRACTOR MATERIAL CONTROL

By A. F. Johnson*

The control of material must necessitate the purchase of material. In general no state has entered into the purchase of material for construction purposes, excepting in highway construction, and so the writer will limit this discussion to material used in highway construction.

The advent of any state into purchasing of material is of recent date, commencing about 1921, and was brought on by the tremendous increase in demand for hard surfaced roads in 1920. This necessitated a big increase in material needed and the existing producers in many cases were not equipped to take care of this large demand for their product. An unusual shipping situation also developed in 1920 and the construction program was slowed down.

The two main reasons that induced some states to purchase material at that time were: 1. To insure sufficient supply of material. 2. To reduce the cost of such material. These same reasons are today the governing factors when a state considers the purchase of material, especially cement, for its Highway work. Therefore, this paper will be devoted mainly to a study of these two factors. An argument has been advanced for states purchasing cement that they would then get a better quality of cement and be assured that the right amount of cement was used. With the inspection and supervision that all states have on road work, there can be no question of quality or quantity whoever furnishes it.

Construction By the State

To insure greater production and lower costs some states did help to finance aggregate producers. One state in order to increase its pavement mileage even went into the construction of roads itself, with disastrous results. To insure a supply of cement and save money, several states bought their cement direct and stored a certain portion for each contract. One state furnished the cement, rock and sand on its work during such a time of material shortage as we had in 1920 and found that it was not helping the situation by its control of material, but was thereby causing friction between its engineering department and the Contractor, and was confronted with claims filed by the Contractor for losses due to non-delivery. That state has gone out of the material business entirely. The writer questions very much that the result would have been any better, if the states had controlled the material during 1920; most likely it would have been worse.

There is at present and will be in the future a sufficient supply of material for road construction and we should not have another 1920. The price has been decreasing irrespective of who furnished the material. This sufficient supply of material has been brought about by the law of supply and demand and not as a result of any state purchasing material direct. Our road program has become stabilized and material requirements are known nearly a year ahead of time.

The writer feels certain that no state is at present contemplating purchasing or controlling aggregate. That contractors can purchase these just as cheap or cheaper than a state is a well conceded fact. This applies also to other material, such as steel, piling, lumber, etc. The cement is the largest single item of material used on road work, therefore, the question of the purchase and control of cement is what we are mostly concerned over.

Purchase for Bridges

For State Highway work, cement is used mainly in pavements and bridges. One state purchases the cement for bridges as well as pavement. Assuming that the state does save the cash discount and the dealer's differential, the writer feels that on work as small as most highway bridges are, requiring only small lots of cement at a time, that if the contractor could purchase his cement from a local dealer, that the value he would receive in using the dealer's storage shed and possibly the dealer doing his hauling, would more than compensate for any saving made by the state in purchasing his cement. The purchase of cement for pavement is therefore the main point of contention.

There are three parties concerned in the control of cement for highway work; the cement company, the state and the contractor. It is quite obvious that a cement company that can sell a large volume to the state at one sale will cut down its selling costs over selling that same amount to a number of different contractors. That cement company would also know at the beginning of the year, its quota of road cement and govern its output accordingly. The writer is inclined to feel, however, that the small producers would be discriminated against, in that the state purchase would most likely be from the large producer, the price of course being the same.

By the state purchasing the cement, what competition there should be is entirely destroyed. In one nearby state, which did not purchase its own cement last year, there developed quite a cement war between dealers and even between producers and the price of cement was cut considerably. The writer doubts that this would have occurred if the state had purchased the cement and surely

*Presented before the American Road Builders' Association on January 13, 1927.

there would have been no reduction in the price of cement to the state.

Supply of Stocks

The question of supply of stocks of cement by companies in general would be no different if the state purchased the cement in January, or if it was left to be purchased by the contractor later in the season. The cement industry is a well-organized business and they take notice of, and provide for the requirements of the State Highway work, whether it is purchased at once or during the season. The contemplated program in any state will be known even before the state can purchase the cement required. That the state is assured of a better supply by storing cement on each job goes without question. This, however, is not done before a contract is let to a contractor and assuredly the contractor can store his own cement just as easily as he can store the state's cement. Furthermore, the state can insist that the contractor purchase at once and store whatever portion of the cement they deem fit.

Now, let us see what saving, if any, a state does make by purchasing its own cement. The states purchasing cement do so generally in January and February. During the last four years, there has been in general a fluctuation of 10c a barrel in the price of cement, the low price occurring in the fall of the year and the advance taking place in January and extending until about October. Last year there was no change in the price of cement. States that have purchased their cement have done so generally in January or February and it is quite evident that they have been paying the high price. Furthermore, if these states were to buy their cement in the fall of the year for the next year's requirements, then no doubt the price of the cement would be advanced at that time rather than in January.

No Dealer's Differential

When the state purchases cement it does not pay the dealer's differential of 10c, which some have considered a saving for the state. The writer questions very much that except in isolated cases, a contractor on paving work does pay any dealer even as much as 5c per barrel differential. In the writer's experience over the past three years and working in two states, 1c per barrel would be a fair average of what he has paid and what other contractors to his knowledge have paid on this dealer's differential. There are, however, concessions made to contractors when they are in the market for the purchase of cement themselves, that the writer feels will overcome any saving in dealer's differential made by the state purchasing this cement direct. There are generally accommodations to be had from the local dealer and also when the contractor has the routing of the cement to make, he will generally get concessions from the local Railroad companies on sidings, service, etc., by giving them the haul. He furthermore has a better control of his sack loss which in some cases has been large when the state has furnished the cement, in which case, the contractor has little if any recourse for adjustment of this loss.

All states, no doubt, would take their 10c per barrel discount on their purchase of cement. A responsible contractor does the same, and if he is not able to take his cement discount he should not be in the business of highway construction. It is the writer's opinion that where the contractor furnishes his own cement that the contractor figures in his cost the net price of cement, that is, with the discount and cost of sacks taken off.

Financing the Purchase

It is quite evident that whoever purchases the cement has to finance same and this must be of some cost to the state and also more clerical work and responsibility falls upon the State Highway Department when they handle the purchase of any material direct. With the addition of this cost to the state, the writer feels that there can be very little, if any, saving in the cost of the cement to the state by its own purchase. If a state was to take two bids on a project at the same time, one where it purchased the cement and the other where the contractor furnished the cement, either bid from a responsible contractor should bring about the same cost to the state. This last year, one state took bids on one job with the state furnishing cement and later on took bids on the same job with the contractors furnishing the cement, with the result that they awarded the job, with the contractor furnishing the cement at a saving of $1,500.00.

There is, however, a saving in the amount of the bond premium by omitting the cement from the general contract. This saving will amount to about $100.00 per mile. By reducing the amount of money involved the state is, however, inviting a lower standard of qualification, which must mean more irresponsible contractors. There surely are plenty of competitors in highway construction without lowering the skill, responsibility and general standing of such competitors. There are, no doubt, enough responsible contractors in the field today to pave twice the mileage contemplated for this year. Furthermore, if we should have a shortage of material like we had in 1920, the state will lay itself open to claims for loss of time, etc., due to non-delivery of any material that the state is furnishing.

Effect on Bids

Let us see how the question of cement purchase affects the contractor's bid in figuring on such work. If the cement is furnished by himself, he will add to his cost an additional premium of about $100.00 per mile for the contract bond. He will also have to use additional finances to carry through the purchase of cement. This is no burden to a responsible contractor, but as a business proposition the extra money involved should be figured with interest at 5 per cent. This rate of interest to take care of handling the cost of sacks, discount and the 15 per cent carrying charge on the work done would amount to about $35.00 per mile of pavement, estimating that each mile of pavement will require about 3,200 barrels of cement. He has, however, complete control of his materials. He will figure in his cost, the gross cost of cement to the dealer, plus a small allowance for the dealer's differential, less the cost of the empty sacks and less the discount. His purchasing department is already organized to take care of the purchase and handling of this and any other material and so this would involve no extra cost to him. He is, himself, responsible for the delivery of this material and in case of shortage and non-delivery, he will not be able to file claims against the state for such non-delivery. In furnishing his own cement he is in an advantageous position with railroad companies, as stated before, and he gains both present and future advantages in dealing with certain cement companies and dealers and thus establishes good business relations.

If the state furnishes cement, his bid will be reduced by this net cost of the cement and also by about $135.00 per mile for smaller bond premium and less carrying charge for financing. He will have to add to this the extra money it will cost on a possible large empty sack loss, loss of the advantages he would otherwise have in dealing with railroad companies, concessions that he might get from good cement company connections, either on this work or future work, and by decrease in his purchasing power and loss of initiative. It is quite evident that the contractor's profit should be the same, whether he or the state furnishes the material. His costs will be different in the two cases, but his actual organization, equipment, work and risk will be the same; therefore, surely he is entitled to, and his profit should be, the same in either case.

Contractor's Preference

In conclusion, a responsible contractor prefers to purchase and control all materials entering into his construction work. He serves the purpose of furnishing:

1. Equipment and organization.
2. Necessary finances.
3. Purchasing power for material and labor.
4. Responsibility for the prosecution and completion of the work involved.

For any and all of these, he will function better and more economically than any other agency. A state purchasing material does not avail itself of the purchasing power of the contractor and tends to destroy his initiative and this without any apparent gain. A state purchasing material means government in business. This has proved uneconomical, as we know, and is contrary to the policy of the present administration and the Government at large.

Water Power—Developed and Potential

There is available in the United States a potential total of 34,818,000 h.p., of water power 90 per cent of the time, and 55,030,000 h.p., available 50 per cent of the time. Of this potential hydro-power from natural sources, 10,100,000 h.p. has already been developed. This total of developed water power represents an increase of nearly one million horse power over the total development as of one year ago. Of the past year's increase in hydro-power development, 99 per cent has been developed by public utilities, only a scant 1 per cent, or approximately 9,500 h.p., has been developed by manufacturing plants.

Because the Pacific states possess the greatest potential water power of any geographical section of the United States (21,260,000 h.p), the development in the west, totaling 2,336,400 h.p., is the greatest sectional development. New England, however, has done more than any other section to develop her natural water power sources, since the total developed horsepower is 1,398,803 of a potential 1,978,000 h.p. Next in order comes the Middle Atlantic states with an actual development of more than two million horsepower out a potential 5,686,000 h.p. The South Atlantic states, however, are not far behind, with their development of 1,600,000 from an available 4,400,000. It is in the mountain states that the greatest percentage of water power is still being wasted—due, largely, to limited consumer demand. In this section there is available more than 15,500,000 horsepower, of which only a scant one million has been developed.

The mechanical development of more efficient power transmission lines and equipment, thus making it possible to transmit electrical energy without excessive loss, would lend impetus to the development of the mountain water power, now being wasted. The engineer solving the problem of efficient power transmission will be of incalculable benefit to mankind and net for himself both fame and fortune.

TESTING OF CEMENT ON A SMALL SCALE APPLIED TO CEMENT BURNING PROCESS

By Prof. Hans Kühl*

IN MY last year's address which dealt with some of the problems of cement testing I pointed out particularly that there was a pressing problem of devising methods of carrying out technical cement testing with very small quantities of cement. I consider the solution of this problem particularly important because cement investigation often deals with very small quantities of substances and because the conditions under which scientific investigations are carried out can be defined generally more exactly, the smaller the quantity of material is with which one works. Numerous striking successes in the investigation of cement problems are due to such work with small and in some cases with extremely small quantities of material; I need only point out the pioneer investigation of the calcium silicates and calcium aluminates by Dr. Otto Schott, the numerous experiments with melts made by the Carnegie Institute in America, the work of Jaenecke on the existense of Jaeneckeite, the investigations of Nacken and Dyckerhoff on the unstable equilibrium in ternary systems. The amount of knowledge which these works have brought to us is very large and yet they do not entirely satisfy us cement technicians for whom they were primarily made, for it was almost never possible to determine quantitatively to what extent the technical properties of the more or less cement-like products agreed with the technical properties of commercial cements. This was true particularly with regard to the most important properties: even the determination of the setting-time and the testing of the constancy of volume is difficult with very small quantities of material; the determination of strength values is practically impossible because a single tensile strength specimen requires about 50 grams of material. Only in exceptional cases have individual investigators been successful by the expenditure of considerable labor in producing a sufficient quantity of a pure preparation to enable them to carry out a few tensile strength tests in accordance with standard specifications; in general they had to satisfy themselves with preparing small cylinders for setting-tests and then evaluating them with respect to their strength by breaking them with the fingers. How much more valuable would the results of the above named investigators have been if they had available a process for measuring quantitatively the technical properties and above all the most important of them, namely, the strength, and comparing it with the known properties of good portland cements. From these considerations I took up the problem of working out technical methods of investigation for all the important properties of cement and cement-like products so as to render it possible to carry out tests with small or even with very small quantities of material. Naturally I could not extend my investigations at once to all the technically important properties; I had to begin at one point and I selected for this strength. I believe that I have succeeded in providing a serviceable method for testing strength on a small scale and I desire to report to you on the work which I have carried out with the aid of my assistants, Dr. Süssenguth and Engineer Ullrich.

Since it was considered impossible to construct a sufficiently exact operating miniature strength-testing apparatus and as the carrying out of compression strength tests on a very small scale would have required a very difficult and, therefore, extremely costly equipment, I turned back to the very origin of all strength tests. I remembered that my teacher Passow had been able to evaluate the quality of cements with a good degree of certainty by breaking off the corners of the flat cakes made on glass plates, and so I arrived at a testing method which consists not in a tearing under tension nor in a compression but rather in a breaking of the sample.

I produced—in order to illustrate the principle of my procedure in brief—small prismatic rods 3 cm* in length and 1 cm square, grasped these rods by their ends in two claws and then broke them by the application of a load exactly as one breaks a rod between the fingers. The apparatus which I used in this case is based on the tensile strength apparatus of Früling-Michaelis. This small size machine is shown in Fig. 1. You see a support in which there is a small foot for holding the prism-shaped sample; above this is arranged a suspension device on which is hung the claw which serves to break the sample; this in turn has a lateral lever at whose free end the force necessary for the breaking of the sample is applied. In carrying out the test the breaking claw grasps the sample from above; after it has seized the sample it is carried swinging freely from it. In order that no breaking moment be produced by the claw itself and the lever attached to it, the claw is provided with an adjustable counterweight which, just as in the case of Michaelis' tension apparatus, can be balanced by moving along a horizontal bar.

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*Translated from "Zement," Nov. 18, 1926, and Nov. 25, 1926. (Lecture delivered Sept. 8, 1926, at the meeting of the Association of German Portland Cement Manufacturers at Hanover, Germany.)

*Note: These rods are 1.2 inches long and have a square cross-section 0.4 inch on a side.

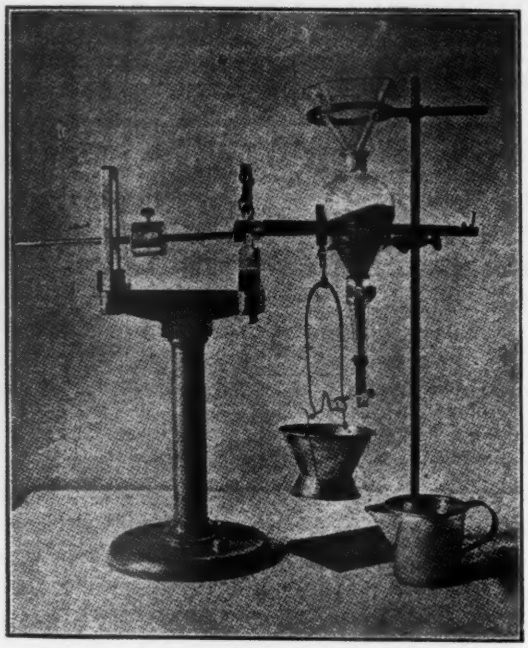

Fig. 1

In the model used heretofore the weight arm of the breaking claw has had a total length of about 30 cm. As we could not predict in advance what force would be necessary for breaking the sample, the weight arm was provided with three notches which were at distances of 10 cm, 15 cm and 30 cm from the breaking claw. As required, the small scoop provided to receive the load of shot is hung from one or the other of these three notches by a brass loop. The practical application of this apparatus showed us that only the shortest lever arm of 10 cm length was used and that accordingly the whole apparatus could have been built more simply and lighter.

I had first thought of applying the load as in the case of the tensile strength apparatus by the automatic addition of large shot; but after it had been determined that the required amount of shot is relatively small I made use of a small size lead shot which was placed in a dropping funnel which was closed at the bottom with a rubber tube and pinchcock. For the time being I regulated the addition of shot by hand and found that in this way I could obtain much more exact results than could be obtained by a mechanical method of addition. As a result of the considerable moment of inertia of a breaking apparatus consisting of claw, lever and counter weight, the sinking of the shot-pail after breaking of the sample has started, proceeds very slowly, and with a mechanical feed considerable time would have elapsed before the addition of shot ceased which would have had as a result the feeding in of a considerably too large quantity of shot.

As the method of holding the sample cannot be seen clearly from the illustration of the entire apparatus, it is shown by itself in the attached Fig. 2. You can clearly see the socket into which the sample is pushed from the side and above it the breaking claw which is suspended over the sample from above. In an improved construction of the apparatus it will perhaps be advisable to equip both the socket claw as well as the breaking claw with an adjustable cheek which can be adjusted by a screw. I recommended to the Göschwitz Cement Factory, which was interested in this apparatus, to equip its model with such adjustable cheeks but I do not know what results were obtained with it.

As the sample has a cross section of $1cm^2$, the strength found by weighing out the amount of shot used is based on the unit of a square cm; the problem now is how to calculate the absolute load for this unit. I give herewith in Fig. 3 a small schematic sketch from which I can make clear to you the considerations which I took into account for this purpose. The problem was to determine such comparative values as would make it possible for us to relate the strength values determined with the strength figures used amongst cement technologists, above all with the tensile strength figures. I have, therefore, considered the breaking of the sample, neglecting the pressure exerted at the point A, as consisting of a continuous tearing from point B to point A, which occurs as a result of the rotation of an imaginary lever BC about the point A. If I assume the phenomenon to occur in this manner, we have acting on the lever on the one hand the turning-moment produced by the load acting at C and on the other hand the resistance produced by the strength of the sample acting over the distance AB. The magnitude of the moment of the load is the product of the load by the lever arm, while the magnitude of the resistance consists of the sum of all the forces which must be overcome in tearing the sample along the distance AB. The sum of these moments I have considered as concentrated, for the purposes of comparison, at the point D midway between A and B: then the moment of resistance which acts against the motion of the lever is the product of the strength value sought by me and of the length of the small lever arm AD which is ½ cm. If I call the load at C "g" and the strength of the sample sought by me which for the sake of simplicity I will call the breaking strength as "x" then I have the equation:

$$x \cdot \tfrac{1}{2} = 10 \cdot g, \text{ whence}$$

$$x = 20g$$

In words this means: using a lever arm of 10 cm I can obtain the desired breaking strength of my sample if I multiply the breaking load *g* by 20. If the breaking load is expressed in kg the snapping strength of the sample is given thereby without further calculation as kg/cm^2.*

Just as the most suitable method of arranging the testing apparatus could be determined only by practical test, so certain considerations had to be taken into account and certain tests made before

*Note: To convert kg/cm^2 to $lbs./in^2$, multiply by 14.

the preparation of the small samples of only 3cm³ volume could be successfully produced. At first there seemed to be 3 methods available: pouring, tamping and pressing of the mass to be formed. I avoided tests with the pouring method from the very beginning as numerous researches have shown that such a pouring method gives poorer agreement amongst individual tests and is to that extent less reproduceable, the smaller the quantities of material are with which the work is carried out. The tamping method seemed to offer at first the desired process because even in testing cements according to the standard specifications tamping is used to produce the desired shape and, because in selecting such a tamping process, at least a certain parallelism would be obtained with cement testing according to the standard methods.

Accordingly Dr. Süssenguth carried out a considerable number of tests to produce samples by the aid of a tamping process either from pure cement or from a cement-sand mixture which would prove satisfactory for the requirements of our testing processes. As the production of a mechanical tamping device would be premature—aside from the fact that very great complications would be inherent in such a method—Dr. Süssenguth tamped the specimens with the aid of a spatula, according to the process in use 20 years ago. With this method results were obtained not exactly unfavorable, but it appeared that the tamping process resulted in considerable variations in individual values, that the strength depended on certain accidental conditions and that the personal element which enters into every testing process using manual methods play an important part. As a result —at first experimentally—we went over to producing the samples not by tamping, but by pressure under the press.

In Fig. 4 is represented the form which we used for producing the pressed samples. You see a cylindrical steel block 3 cm thick in which a slot is cut, 3 cm long and 1 cm broad. The form is placed on a steel plate and is filled with the material to be molded to such a height that the quantity of material introduced is somewhat larger than corresponds to the volume of the briquet to be produced. Alongside of the steel form you see the die which has a length and height of 3 cm and thickness of 1 cm and fits exactly into the slot of the form. After the mass to be briquetted is placed in the form the die is adjusted and the whole is brought under the press. At first the shaft of the press is adjusted by hand and then the pressure is slowly increased until the desired intensity of pressure of 400 kg/cm² is attained. As the surface to be pressed amounts to only 3 cm² the absolute load is only 1200 kg; this relatively small load is obtained with sufficient exactness by the aid of the small structural material tester of the clay industry when the press is adjusted for small travel.

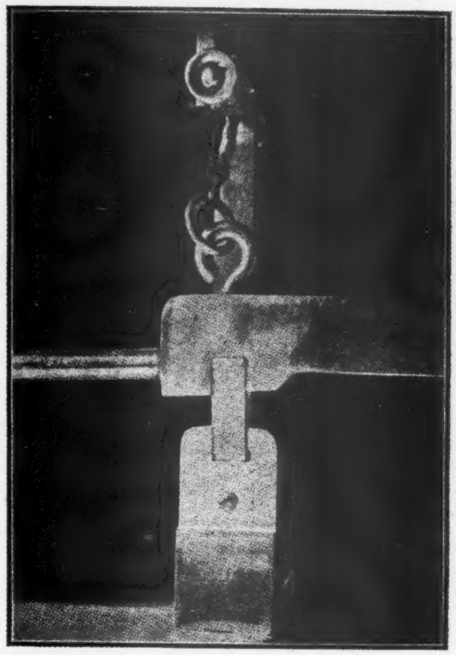

Fig. 2

After the molding, two of the steel rods 1 cm thick are laid underneath the form and two similar steel rods on the form. Then the female die is driven home into the press by adjustment of the press so that the male die is forced against the steel rods on top and consequently the part of the material remaining in the slot of the form takes on a thickness of 1 cm. The excess mortar is forced out of the form; after turning the form around it is removed by carefully scraping with a knife. Then after laying the pair of steel rods on the inverted form the die is forced completely into the form and the sample is thus pushed out of its mold. The sample so produced has a cross section area 1 cm on an edge and a prism length of 3 cm and thus corresponds exactly to the dimensions required for testing. It is laid carefully on a glass plate and in exactly the same manner as is used in standard testing, it is allowed to remain at first for 24 hours in a moist box and then as required is used for hydraulic testing, air testing, or combination testing. For the time being I have made all my tests under the conditions of hydraulic setting.

The process which I have just described in its broad outlines naturally permits the testing of any desired mortar mixture from a pure cement mortar up to the leanest mixtures. At first I had thought of utilizing pure cement mortar for the working out of a standard method because the use of sand would naturally introduce a new element requiring standardization in my testing method. The fact that later I went over to a 1:3 sand mixture is due to the fact that I desired to use the smallest possible quantities of cement. It is, of course, clear that the amount of cement needed drops to one-fourth if we make our tests with a 1:3 sand mortar mixture instead of with pure cement.

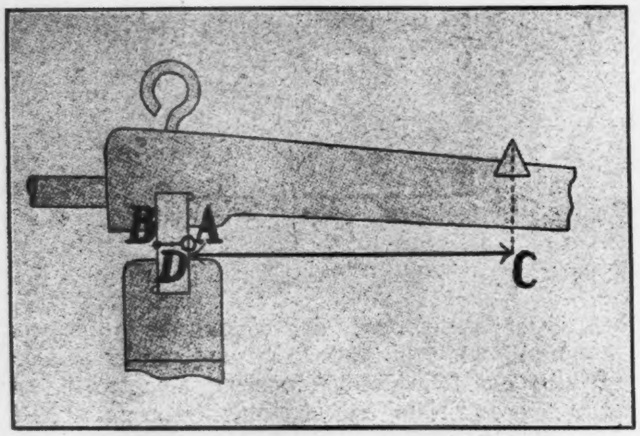

Fig. 3

After the decision had been made in favor of a sand mixture the question arose of obtaining a sand suitable for this process. Ordinary standard cement was excluded from the beginning because of its coarseness, for since the new testing method used a cross section of mortar only 1cm² in size, the individual grains of sand had to be so small that, as compared to the cross section of the sample, they would have a magnitude of the second order. Therefore, I prepared the sand with which I work from standard sand by taking a considerable quantity of standard sand, crushing it coarsely in a ball-mill and from the sand of mixed size of grain so obtained I selected the grains of an average size by means of the screens with 225 meshes/cm² and 900 meshes/cm².* The sand utilized by me for this small scale testing thus passes completely through the screen with 225 meshes and remains completely on the screen with 900 meshes; accordingly its grain size lies between 0.22 and 0.44 mm.

The choice of the amount of water to be added at first offered difficulties. At the beginning a considerable amount of care was taken to find the amount of water to be added to produce a mortar which would become plastic on tamping. It is not necessary to report on this experimentation as the final scheme of my process provides for filling the form by pressure instead of by tamping. The difficulties in selecting the amount of water to be added were, however, not overcome by this change. I made comparative tests with varying quantities of water both with pure cement and with mortar mixtures in the 1:3 ratio and I present them in Fig. 5 in the form of an abstract of the results of the tests with samples which were finished at a pressure of 300kg/cm² (which was the pressure being used at that time). It will be seen that in the case of the neat material the strength did not appreciably change when the addition of water exceeded about 12 per cent, and that in the case of the mortar tests strength figures were attained with water additions of 8-10 per cent which were not appreciably increased by further additions of water. It is perhaps striking that an excess of water does not seem to diminish the strength. A careful consideration indicates that an excess of water can hardly be used because in the pressure process the excess water is forced out from the sample, and consequently disappears from further participation in the test.

*Note: 225 meshes 1 cm² corresponds to 37.5 meshes per linear inch, and 900 meshes lcm² to 75 meshes per linear inch.

Figure 5
Influence of Water Addition on the Strength
(Pressure 300kg/cm²)

Mortar 1:3			Neat Cement		
Water	3 days	7 days	Water	3 days	7 days
2%	2.8	2.9	6%	13.5	27.3
4%	4.0	4.3	9%	14.9	29.7
6%	6.4	8.5	12%	26.3	37.8
8%	9.2	11.0	15%	24.7	35.0
10%	9.4	13.3	18.8%	30.5	37.0
11.3%	10.0	13.7			
13%	10.5	13.7			

Based on this consideration I did not develop a process to determine the water requirements for the samples used and instead simply fixed the amount of water to be added to mortar tests at 11 per cent and to neat cement tests at 18 per cent. These figures were selected on the basis of numerous experiments and have justified themselves; they were so determined that the addition of water is unquestionably sufficiently high to assure complete development of the hardening power, while on the other hand an expression of too much water during the production of the sample is avoided.

As in the case of determining the amount of water to be added, the selection of the pressure to be used required a complete investigation. In Fig. 6 is presented a small table from which the effect of the pressure on the strength of the specimens is shown. You will see, as was to be expected, that the strength increases with rising pressure but that an increase in pressure from 300 to 400 kg/cm² no longer produces an increase of strength of any great importance. On the basis of these results the pressure for producing the samples both for mortars and for neat cements (in so far as these were at all produced) was simply fixed at 400 kg/cm².

Figure 6
Influence of Pressure on the Strength of
1:3 Samples After 3 Days

	Strength	
Pressure	1:3	Neat Cement
100 kg/cm²	6.3	27.5
200 kg/cm²	8.8	28.7
300 kg/cm²	9.2	33.1
400 kg/cm²	11.0	37.4
Tamped	16.4	42.0

It probably appears strikingly strange that the absolute value of the strength figures which were found for pressed samples is by far lower than the value of the strength figures which were obtained with tamped samples in the case of both pure cements and mortars. This observation is not at all new as quite similar determinations were made by Guttmann who reported his experiments recently (Zement 1926, No. 2). It must be concluded both from Guttmann's observations and from my own figures that by far not so close a packing of the particles of the mortar mass is obtained by pressure as results from the vibration which accompanies the tamping. However, this fact still remains surprising if we take into account the fact that the removal of water from the sample shows that during the pressure process a complete filling up of the pores is obtained. Apparently after the release of the pressure elastic after-effects occur which do not appear if the compression of the mass is produced by the work of tamping united with vibration.

And finally it may be pointed out that the duration of the pressure action might be of importance in fixing the test results. I have undertaken no investigations on this point but have allowed for this consideration by prescribing that the pressure is to be increased by slowly turning the shaft and that after the pressure of 400 kg/cm² is once attained it is to be held for exactly one minute at this point; the release of pressure is then obtained by slowly releasing the pressure shaft.

I have applied this new testing method recently to practically all the cement tests which were sent to my laboratory. Thus it became possible in spite of the shortness of time to collect quite an amount of data which could be used in judging the applicability of my testing method and at the same time would offer a certain basis for a comparison of the breaking strength values with the current figures for standard tensile and compression strengths.

From a purely qualitative point of view it may be said at once that the breaking strength values are relatively small; I found values between 5.9 and 17.9 kg/cm² in material to be tested consisting of 43 cements, the tensile strength values of which lay between 14.8 and 41.8 kg/cm² and the compression strength of which lay between 179 and 550 kg/cm²; I consider the cause of this small value of the breaking strength, as was indicated before, to the utilization of a relatively fine sand and above all to the method of preparing the test samples.

It is very interesting that the smallest strength value found bears the same ratio to the largest strength value found of 1:3 in the case of the breaking strengths (5.9:17.9), and for tensile strengths (14.8:41.8) and finally for compression strengths (179:550). This shows that in the three methods of testing strength the difference between a poor and a good cement is equally large in each case, or, in other words, that each of the three strength figures offers a method of evaluating the

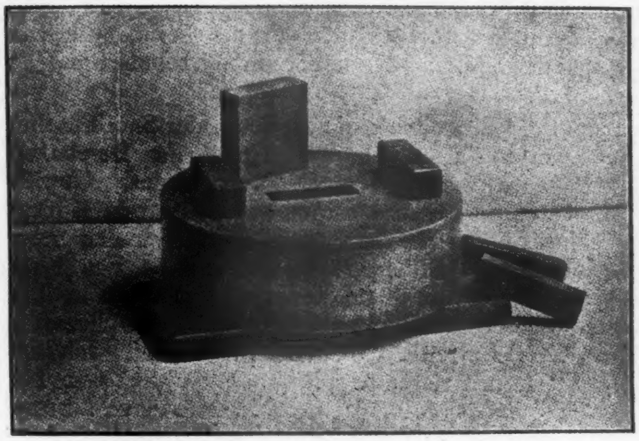

Fig. 4

quality of a cement which can be relied on equally well.

However, this does not mean to say that the decision will always be the same whether we test a cement for its tensile strength, its compression strength or its breaking strength! On the contrary, it has long been known that the tensile strength is by no means parallel to the compression strength, that together with a ratio of 1:10 for tensile strength: compression strength there may also be a similar ratio of 1:20—and similar relationships hold for the breaking strength. We can thus by no means calculate the tensile strength or the compression strength from the breaking strength; however, certain approximate relationships do exist which permit us to judge the tensile strength and the compression strength at least crudely from the breaking strength.

In such examinations of the available quantitative figures we first observe—as is indeed to be expected from the close relationship of the two methods of testing—that the general course of breaking strength figures is more closely allied to the tensile strength values than to the compression strength values; the breaking strength, like the tensile strength, is very sensitive to slight variations in the hardening process; it does not so easily permit the attainment of record values and in this respect from the scientific viewpoint—and this alone is of importance—is undoubtedly superior.

If we desire to obtain from the breaking strength values an evaluation of the figures which are obtained in the standard tests for tensile and compression strengths, the breaking strength values

Figure 7
Conversion Figures

Conversion Figures	Compression Strength / Breaking Strength			Tensile Strength / Breaking Strength		
	3 days	7 days	28 days	3 days	7 days	28 days
Average	2.38	2.24	2.06	31.3	32.4	30.5
Minimum	1.8	1.6	1.6	23	25	26
Maximum	3.5	3.0	2.6	41	44	39

must be multiplied by factors the values of which are, as a first approximation, 2 for the tensile strength, and 30 for the compression strength. More exact details as to these factors and their deviations from their mean value can be seen in Fig. 7. In the uppermost line are the mean values for the factors to be used which are obtained from all the tests which were carried out.

Accordingly the factor for the tensile strength is a little above 2, and, in addition, it drops somewhat as hardening proceeds, whereas the compression strength is attained by multiplying by a factor which for the 3 groups of varying age lies rather uniformly a little above 30. In the table of figures given, the highest and the lowest values of the factors are also reported; they are in the second and third line and it will be seen that the deviations from the average value are quite appreciable in the extreme cases but nevertheless are not larger than are observed in the ratio between tensile strength and compression strength. In the case of the large deviations we are dealing with relatively rare variations from the general course, as can be seen by examining the summary of the magnitude of the deviations depending on their frequency, as shown in the attached Fig. 8.

Figure 8

Deviations of Conversion Figures from the Average

Deviation	Tensile Strength Breaking Strength 3 days	7 days	28 days
up to 10%	21 (49%)	17 (43%)	23 (62%)
10-20%	14 (32%)	13 (32%)	8 (22%)
above 20%	8 (19%)	10 (25%)	6 (16%)

Deviation	Compression Strength Breaking Strength 3 days	7 days	28 days
up to 10%	25 (58%)	21 (53%)	25 (69%)
10-20%	14 (33%)	14 (35%)	9 (25%)
above 20%	4 (9%)	5 (12%)	2 (6%)

It is seen that the deviation from the average value to the extent of 10 per cent above or below accounts in the case of the tensile strength for 43 to 62 per cent of all the cases and for compression strength for 52 to 59 per cent of all the cases, in which, strangely enough, the deviations for the 7-day strength are larger than for 3-day strength whereas the 28-day strength values show the greatest uniformity. In both of the following lines it will be seen that the deviation from the average value for a number of cases still appreciably large does not exceed 20 per cent, whereas the number of cases in which the deviation exceeds 20 per cent while not exactly very small is, looking at it as a whole, not altogether large. On the whole it may be said that the tensile strength and the compression strength may be obtained correct within 20 per cent with a high degree of probability if the breaking strength is in each case multiplied by the figures given in the line for the average values in the above table, Fig. 7.

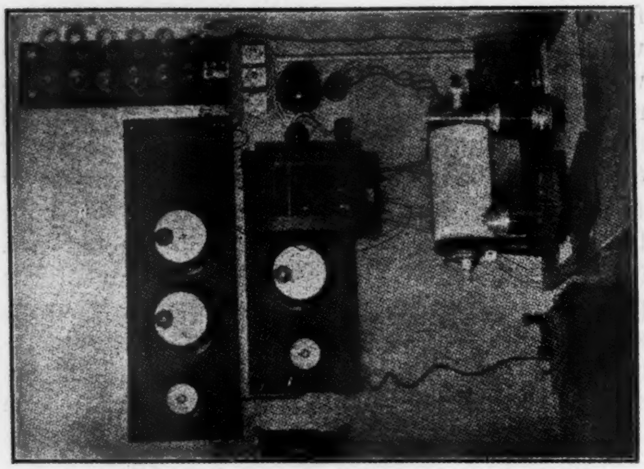

Fig. 9

For the sake of completeness I might state that in a number of cases the strength values for neat cement were also measured according to the new method. The figures obtained are naturally much larger than for the mortar samples; they vary in their most extreme values between 21.7 and 59.3 kg/cm^2. Parallel tests for determining the tensile strength and the compression strength were not made in the case of these neat cement samples.

Finally a word about the distribution of the individual values. In determining the strength figures I carried out four individual tests in each case; this seemed to me to be sufficient as the distribution is appreciably smaller than in standard tensile strength testing. For example, in the case of an average value of 11.0 kg the lowest value was 10.3 and the highest value 11.7 kg. In another case where the average value was 12.8 kg the lowest value was 12.4 kg and the highest value 13.9 kg. These are examples selected at random without looking for good cases. Figures completely outside of the average were observed only in quite exceptional cases just as, as is well known, occurs from time to time in determining the tensile strength. In general the larger deviations from the average value were observed only in such cases where the strength was rather low, whereas with good strength the distribution was always within narrow limits.

The testing of breaking strength with prismatic specimens permits naturally also a direct measurement of the compression strength if for this purpose the two pieces of the broken specimen are used. I have carried out such tests by placing both pieces alongside of each other under the pressure die of the material tester used in the ceramics industry and compressed them, using the small travel of the press. The results show a considerable distribution in the individual value; they consequently can have no claim to high accuracy and, therefore, I do not report them. However, it may not be without interest to state that the compression strength values determined in this manner are hardly half as large as in the case of standard testing. There is thus between the compression strength determined by this small scale method and the compression strength according to standard methods the same ratio with a considerable degree of approximation as between breaking strength and tensile strength. The basis in both cases is probably the same: the use of fine sand and the preparation of the specimen by pressing instead of by tamping.

If in the above paragraph I have described the new testing method rather in detail, I might in conclusion mention certain results of the first scientific work for which the new method was utilized. Engineer Ullrich has conducted a doctoral research in my laboratory in which he studied the influence of burning temperature, time of burning, and rate of cooling on the properties of portland cement. Investigations of this kind have been carried out repeatedly; but they have never led to really positive results as in the case both of the kilns used in practice and the furnaces heretofore used in laboratories the maintenance of exact research conditions has been almost impossible. Mr. Ullrich has consequently entered upon a totally new path and has carried out his burning tests on a very small scale in electrically heated furnaces. He has used in some cases a tube furnace with platinum winding made by the firm of W. C. Heraeus, and in other cases a muffle furnace of the firm of Uhlendorff of Berlin in which the heating is by means of "silid" rods. In both furnaces the temperature can be adjusted extremely exactly by regulating the current and both furnaces permit the measurement of the temperature by the use of thermo-elements with a degree of accuracy not at all obtainable in technology; the deviations do not exceed several degrees C. I desire to outline the method of working with the electrical furnaces very briefly without anticipating the publication of the doctoral thesis of Mr. Ullrich in its important points:

In Fig. 9 you see the apparatus which Mr. Ulldich used in working with the silid muffle furnace. The furnace itself can be clearly seen, the equipment for leading in the current, as well as the temperature measuring devices consisting of a platinum-platinumrhodium thermoelement and a millivoltmeter for the fine adjustment of current strength and with it of the temperature. There was used together with the main regulating resistance, which is set up on the wall, a fine regulating resistance which is on the working table near the furnace and by means of which it was possible to subdivide the relatively large intervals of the main resistance into ten parts. In this manner it was possible to adjust the temperature of the furnace so exactly that measurable fluctuations did not occur even in experiments covering a considerable period of time.

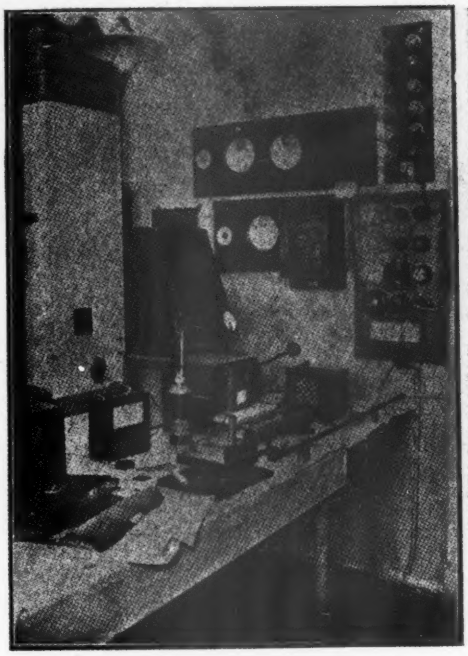

Fig. 10

The experimental arrangement for the tube furnace is quite similar, as shown in Fig. 10. Attention is particularly called to the furnace itself. It can be seen how at both ends of the furnace the tube to be heated projects from the heating tube constructed with platinum winding; this relatively narrow heating tube is built of Marquardt's mass; on account of its small size it can be heated relatively easily and maintained at constant temperature. The charge to be burned is placed in it.

In all burning tests involving ceramic materials the selection of a material for the container offers the very greatest difficulties as outside of the noble metals there is no material which does not react with the materials to be burned at high temperatures; this difficulty is particularly large in the case of the otherwise convenient Heraeus tube furnace as the Marquardt tube never fails to break on cooling if it has come into contact with the charge to be burned at the high temperature. We overcame this difficulty by the following method of working:

A rod of the thickness of a heavy lead pencil was made from the moistened raw flour and this, after drying, was wrapped in platinum foil and introduced into the heating tube of the furnace. Such a rod is burned to a clinker under conditions of speed of heating, burning temperature, time of burning and speed of cooling determined in the most exact manner, that is to say, completely defined in the sense of the problem studied by Mr. Ullrich. Such a rod of clinker is first broken up with the hammer to the size of approximately standard sand and is then ground up in a small

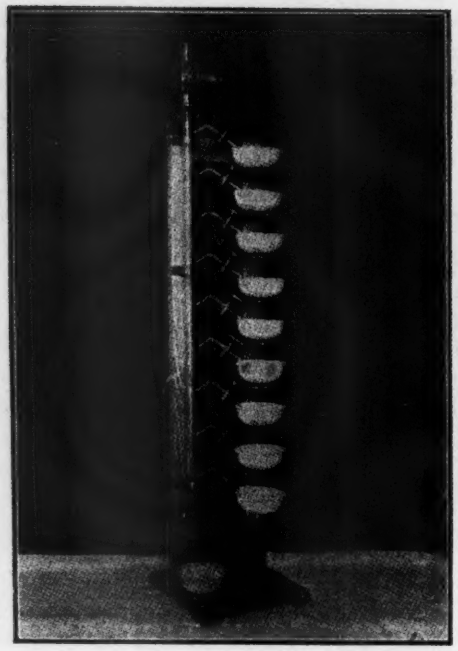

Fig. 11

porcelain ball mill to a predetermined degree of fineness and is then subjected to small scale testing for breaking strength according to the method described. In this way completely reproduceable experimental results are obtained. What this signifies can be estimated by anyone who has ever been plagued by "test burnings" made in the hitherto common manner with their numerous uncontrollable sources of error. As Mr. Ullrich has not yet completed his work I am unable to give you a report on the results of the tests; I shall mention only one extremely interesting result in brief. Mr. Ullrich in part of his work chilled the glowing clinker with water and observed the following: In all cases in which the clinker on chilling still had a temperature above 1275° C. no matter how high it had been heated before, it showed a reddish brown appearance; but on the other hand, if it was first cooled to a temperature below 1275° C. and then suddenly chilled it showed the normal greenish-black appearance of portland cement clinker exactly as in all cases in which the clinker was slowly cooled. These observations quantitatively confirm certain conclusions which I had already reported briefly (Zement 1926, No. 26, page 456). The appearance of red and brown colors in burned clinker has nothing whatever to do with oxidizing or reducing flames, as has hitherto always been assumed, but is entirely a function of the temperature and the rate of cooling.

After this short digression into the application of the small scale testing of cement permit me to return for a little while to small scale testing itself. I have reported only on the process for determining strength, but am convinced that the working out of further processes for small scale testing of other important properties of cement is desirable and I may add that I am already occupied with the investigation of the property which is often of striking importance in hardening, namely, with the fineness of cement. In connection with certain older works of Weigner (Kolloid-Zeitschrift, vol. 31, page 271, 1922), v. Hahn (Wissenschaft und Industrie, vol. 1, page 86, 1922), Gessner (Kolloid-Zeitschrift, vol. 37, page 115, 1926), Bauer, Guttmann (Reports of the Research Institute of the Cement Industry at Düsseldorf, Iron Portland Cement Division—Zementverlag 1926), and others, I have built an apparatus which uses the velocity of sedimentation as a measure of the particle size of the cement, and which renders it possible to obtain with small quantities of cement of a few grams very exact measurements of its particle composition. This apparatus is shown in Fig. 11.

The apparatus is 1.20 meters high and consists principally of a long glass tube provided with side outlets which is filled with alcohol and serves as the sedimentation vessel. At its upper end the tube has a brass attachment which can be closed in the middle by means of a cock with a correspondingly wide bore. The apparatus is filled completely with alcohol right up to the top edge of the brass attachment. Then the upper part of the attachment is cut off by means of the cock, and the cement to be tested (about 2 grams) is brought into the upper part of the brass attachment which is cut off from the closed lower part by means of the cock and is then stirred up to a thin suspension with the alcohol contained in it. Before a settling out of the stirred up cement can occur the cock is turned and thus the connection between the stirring space and the sedimentation space is brought about. The sedimentation begins at once and has as a consequence that after sufficient time the cement has arranged itself in layers according to its particle size along the whole length of the tube. Then in rapid succession all the cocks on the side outlets, starting at the top and going downward, are opened so that the alcohol flows in 10 fractions into the dishes placed beneath the outlets, carrying with it the cement particles still in suspension. The cement caught in the ten dishes is then separated from the alcohol by filtering, dried and weighed.

I regret that I cannot report quantitative results as the new apparatus has just been completed and put into use; I hope soon to be able to publish some results in the technical press and hope that this apparatus will prove serviceable not only for the small scale testing of cement but also for the measurement of the fine particles of all cements which have hitherto not been measurable by means of screens. The further extension of small scale testing will thereafter have as its goal the production of working methods for the determination of setting time and constancy of volume on a small scale —but this is still in the distant future.

ANOTHER BIG BUILDING YEAR AHEAD

By C. Stanley Taylor

THE closing figures of the year 1926 show an astounding total national expenditure of well over $6,000,000,000 in new building construction. Including alterations and unrecorded transactions, this total probably measures over $7,000,000,000, thus establishing for the past year an unprecedented record of construction activity and one which probably will be unequalled for many years to come.

When the figures were tabulated for 1925, it was felt that that year had probably established a total which might never be equalled, and while the conservative forecasts for 1926 promised another six billion dollar building year, it was not conceived by anyone that this figure would be as greatly exceeded as it has been.

Similarly, it is difficult to conceive that the year 1927 will record as great a national building investment as that of 1926. All indications point to the fact that while 1927 will probably prove to be one of the great years of building history, its total investment in new building construction will be approximately 12 per cent less than in 1926. In other words, the forecast of The Architectural Forum, based on an extensive survey as explained in following paragraphs, indicates for 1927 a total of about six billion dollars as opposed to the seven billion dollar record of 1926.

For several years past, The Architectural Forum has carried out a comprehensive survey among architects, obtaining over 2,000 confidential reports of work actually on the boards or seriously contemplated to reach the contract stage the following year. Having those actual figures in hand, it has been found possible to apply a series of ratios which have resulted each year in a fairly close approximation of actual figures ultimately recorded. Primarily, of course, this forecast deals with work carried out through architects' offices, but with the exception of small residential work (houses under $10,000), and factory buildings, the bulk of the building of this country is controlled by architects. To the figure established by new work must, of course, be added an estimate covering remodeling and alterations. This is presented in mere detail in later paragraphs.

For those who wish to review and compare building activity since 1915, there is shown herewith a classification chart recording monthly totals of plans filed, contracts let and the volume of new building as measured in cubic footage. These figures are primarily based on reports of the F. W. Dodge Corporation. There is shown also an index of building cost which offers an interesting comparison with the activity during any period of the past.

In order that some detailed measure may be had of anticipated building activity during the year 1927, the architects' reports received by The Architectural Forum have been correlated and weighted for presentation in the accompanying table which shows the expected activity in 19 types of buildings, allocated to six divisions of the country. This tabulation shows a total of $4,856,817,500, which it is believed represents the approximate value of the new construction which will be planned and executed in 1927 through architects. In addition to this, there will be several hundred million dollars expended for small residences in rural districts, which do not come within the architect's scope of service, together with a large volume of industrial building and a considerable program of remodeling, a part of which is handled by the architect, but which is not recorded in this table. In total, therefore, the forecast for 1927 exceeds six billion dollars.

It is quite probable that a considerable part of the decrease in building activity in 1927 as compared to 1926 will be found in the cutting down of cheap speculative building. From important mortgage money sources it is learned that the constantly growing tendency is to discourage flimsy construction, and the supervision of specifications has been developed to a considerable degree of efficiency as compared to the poor methods of control exercised in past years.

Of course, one of the principal reasons for the great volume of building activity during 1926, and as anticipated for 1927, is the desire of the public for better housing of all kinds and for a more modern and attractive environment in which to carry on commercial and institutional functions. We must also take into consideration the rapid establishment of new residential districts (due to transportation improvements) and the growing habit of developing new business centers in the larger cities —areas where certain trades are becoming concentrated. This tendency is noteworthy not only in New York but in practically all of the larger cities in the country.

Coupled with these greatly increased standards of social and commercial housing conditions, there is the significant fact that the continued period of prosperity has placed the public in a position to pay for what it wants in the way of new buildings.

In spite of occasional comments, there appears at present no great danger of overbuilding, because, after all the building demand of this country is not primarily for space alone, but for space of a

BUILDING TYPES	N EASTERN STATES	N ATLANTIC STATES	S. EASTERN STATES	S. WESTERN STATES	MIDDLE STATES	WESTERN STATES	U.S.A.
Automotive	$8,605,000	$37,070,000	$8,887.500	$8,735,000	$52,365,000	$21,470,000	$137,132,500
Banks	16,000,000	81,425,000	4,485,000	6,700,000	41,050,000	8,997,500	158,657,500
Apartments	21,757,500	331,602,500	14,500,000	25,317,500	157,047,500	57,775,000	608,000,000
Apartment Hotels	6,337,500	117,362,500	5,562,500	5,675,000	48,150,000	25,150,000	208,237,500
Clubs Fraternal, etc.	11,882,500	62,362,500	9,687,500	12,395,000	73,667,500	37,845,000	207,840,000
Community and Memorial	4,337,500	29,570,000	1,112,500	18,815,000	31,275,000	11,522,500	96,632,500
Churches	39,345,000	99,840,000	12,937,500	35,402,500	90,960,000	36,415,000	314,900,000
Dwellings *(Under $10,000)	8,555,000	40,607,500	7,925,000	12,990,000	31,867,500	13,875,000	115,820,000
Dwellings ($20,000 to $50,000)	7,925,000	39,687,500	6,095,000	11,940,000	38,737,500	12,095,000	116,480,000
Dwellings (Over $50,000)	8,075,000	33,520,000	2,212,500	5,915,000	29,220,000	11,387,500	90,330,000
Hotels	20,970,000	92,442,500	25,762,500	37,725,000	92,950,000	66,917,500	336,767,500
Hospitals	17,850,000	126,937,500	7,850,000	18,465,000	78,222,500	23,622,500	272,947,500
†Industrial	42,362,500	134,205,000	2,415,000	18,555,000	139,455,000	17,797,500	354,790,000
Office Buildings	32,250,000	194,140,000	7,757,500	47,385,000	267,845,000	68,250,000	617,627,500
Public Buildings	28,102,500	102,027,500	6,950,000	10,912,500	65,845,000	56,440,000	270,277,500
Schools	52,900,000	144,950,000	24,770,000	43,325,000	219,080,000	81,215,000	566,240,000
Stores	5,417,500	42,025,000	14,072,500	7,567,500	25,487,500	12,497,500	107,067,500
Theaters	18,637,500	54,747,500	6,995,000	11,012,500	93,367,500	14,892,500	199,652,500
Welfare Y.M.C.A., etc.	7,425,000	24,167,500	4,262,500	4,745,000	30,537,500	6,280,000	77,417,500
TOTAL VALUE OF NEW BUILDINGS	$358,735,000	$1,788,690,000	$174,240,000	$343,577,500	$1,607,130,000	$584,445,000	$4,856,817,500

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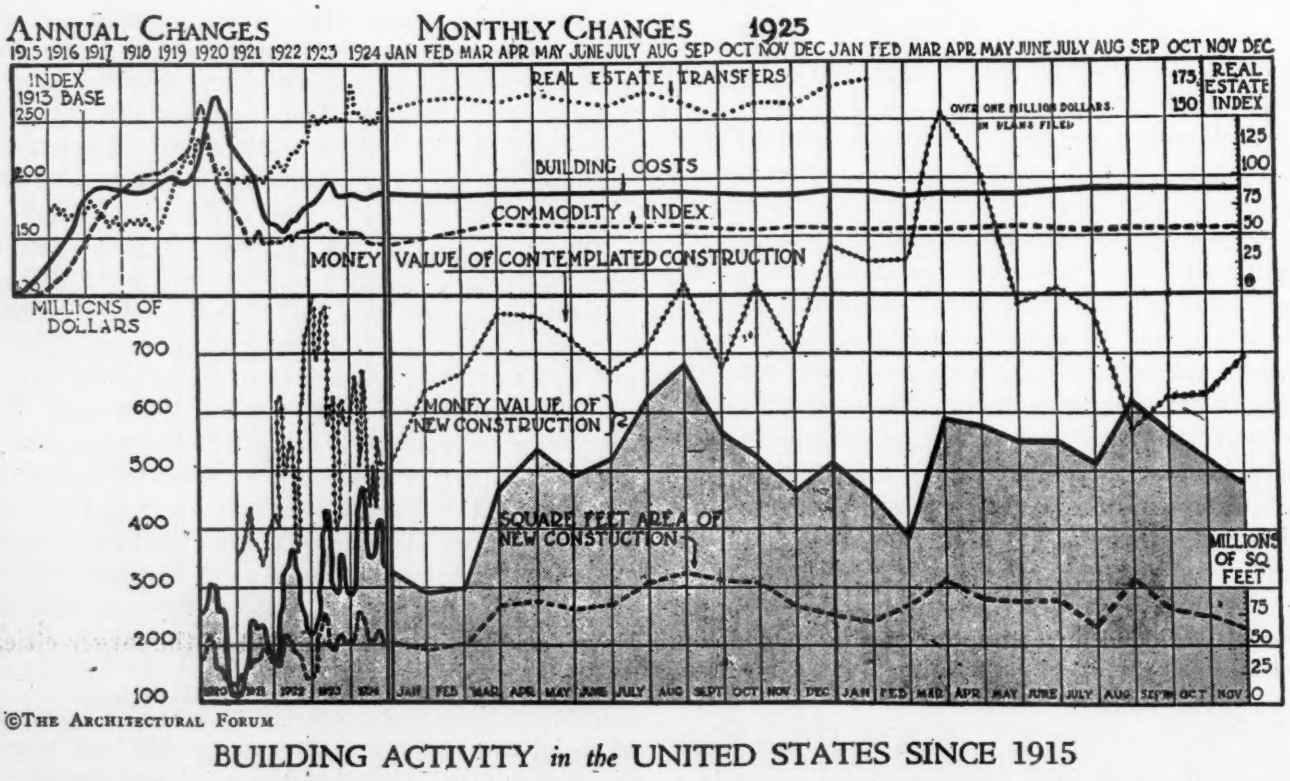
DETAILED FORECAST *of* NEW BUILDING CONSTRUCTION *for* 1927

(These figures represent only work being planned by architects)

*Architects plan only 20% of small houses—multiply figures by 5 for grand total. †Architects plan 50%



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BUILDING ACTIVITY *in the* UNITED STATES SINCE 1915

satisfactory quality. Here then we find conditions which are certainly discouraging from the viewpoint of owners of old buildings, particularly those which physically or because of local conditions are approaching the state of obsolescence. The competition of new buildings will naturally be too great to sustain values in old structures, but it is probable that the new buildings themselves will not suffer materially except in isolated instances of a temporary satiation. In certain districts of New York, it may be said that 1926 has seen an overbuilt condition in certain types of buildings, such for instance as in the so-called "garment center" and in the office building situation in the Grand Central zone. While space competition is definitely in view in these districts, it is probable that this condition is, after all, only one of a year or two and that all of this modern manufacturing and commercial space will be readily absorbed by developing industrial and commercial needs for space.

One of the most interesting phases of any building forecast is to be found in attempting to measure the change in public demand for new buildings, both as to building types and geographical divisions of the country. The figures of The Architectural Forum's forecast have been carefully analyzed from this viewpoint in order that a comparison may be made with the public demand for various types of buildings as expressed in January of 1926. The following tabulation shows in detail the change in demand in 19 building types and six divisions of the country, as well as the national total.

A Comparison of Public Demand for New Buildings as Shown in 1926 and 1927

The figures given below apply to projects as reported by architects and represent the percentage of the valuation of each building type as compared with the total value of projects for the district.

United States

Type of Building	Requirements for New Buildings by 1926	1927	Percentage Change
Automotive	2.7	2.8	.1
Banks	3.3	3.3	
Apartments	10.8	12.5	1.7
Apartment Hotels	3.4	4.3	.9
Clubs, Fraternal, etc.	4.6	4.3	.3
Community & Memorial	2.7	2.	— .7
Churches	5.1	6.5	1.4
Dwellings (under $20,000)	4.1	2.4	—1.7
Dwellings ($20,000 to $50,000)	2.3	2.4	.1
Dwellings (above $50,000)	1.5	1.9	— .4
Hotels	10.5	6.9	—3.6
Hospitals	5.5	5.6	.1
Industrial	8.7	7.3	—1.4
Office Buildings	11.9	12.7	.8
Public Buildings	4.	5.6	1.6
Schools	12.4	11.7	— .7
Stores	2.2	2.2	
Theatres	3.1	3.9	.8
Welfare, Y.M.C.A., etc.	1.2	1.7	.5

Northeastern States

Type of Building	Requirements for New Buildings by 1926	1927	Percentage Change
Automotive	5.4	2.5	—2.9
Banks	4.1	4.5	.4
Apartments	5.6	6.	.4
Apartment Hotels	1.9	2.	.1
Clubs, Fraternal, etc.	3.5	3.	— .5
Community & Memorial	4.	1.1	—2.9
Churches	8.8	10.9	2.1
Dwellings (under $20,000)	2.6	3.	.4
Dwellings ($20,000 to $50,000)	2.2	2.	— .2
Dwellings (over $50,000)	1.6	2.	.4
Hotels	10.	5.6	—4.4
Hospitals	7.9	4.8	—3.1
Industrial	9.5	11.9	2.4
Office Buildings	8.6	8.9	.3
Public Buildings	4.1	8.	3.9
Schools	15.3	15.	— .3
Stores	1.9	1.4	— .5
Theatres	1.7	5.4	3.7
Welfare, Y.M.C.A., etc.	1.3	2.	.7

North Atlantic States

Type of Building	Requirements for New Buildings by 1926	1927	Percentage Change
Automotive	2.1	2.1	
Banks	2.7	4.5	1.8
Apartments	16.1	18.5	2.4
Apartment Hotels	2.6	6.6	4.
Clubs, Fraternal, etc.	3.9	3.5	— .4
Community & Memorial	2.6	1.6	—1.
Churches	3.9	5.6	1.7
Dwellings (under $20,000)	5.1	2.3	—2.8
Dwellings ($20,000 to $50,000)	2.4	2.2	— .2
Dwellings (over $50,000)	1.4	1.9	.5
Hotels	6.4	5.2	—1.2
Hospitals	5.5	7.1	1.6
Industrial	12.2	7.5	—4.7
Office Buildings	11.8	10.9	— .9
Public Buildings	3.9	5.7	1.8
Schools	12.5	8.1	—4.4
Stores	1.9	2.4	.5
Theatres	1.3	3.	1.7
Welfare, Y.M.C.A., etc.	1.7	1.3	— .4

Southeastern States

Type of Building	Requirements for New Buildings by 1926	1927	Percentage Change
Automotive	3.	4.6	1.6
Banks	3.	2.3	— .7
Apartments	12.2	8.4	—3.8
Apartment Hotels	3.8	3.2	— .6
Clubs Fraternal, etc.	5.6	5.2	— .4
Community & Memorial	1.4	1.	— .4
Churches	5.3	6.9	1.6
Dwellings (under $20,000)	6.1	4.	—2.1
Dwellings ($20,000 to $50,000)	3.1	4.2	1.1
Dwellings (over $50,000)	1.6	1.1	— .5
Hotels	18.	15.	—3.
Hospitals	2.7	5.	2.3
Industrial	2.	2.	
Office Buildings	11.7	5.	—6.7
Public Buildings	6.	4.	—2.
Schools	6.9	13.8	6.9
Stores	3.4	8.	4.6
Theatres	2.	4.	2.
Welfare, Y.M.C.A., etc.	2.2	2.3	.1

Southwestern States

Type of Building	Requirements for New Buildings by 1926	1927	Percentage Change
Automotive	2.8	2.8	
Banks	6.2	2.	—4.2
Apartments	5.2	8.	2.8
Apartment Hotels	2.6	2.	— .6
Clubs, Fraternal, etc.	4.4	4.	— .4
Community & Memorial	2.7	5.2	2.5
Churches	11.6	10.2	—1.4
Dwellings (under $20,000)	3.8	3.5	— .3
Dwellings ($20,000 to $50,000)	3.3	4.	.7
Dwellings (over $50,000)	1.6	1.5	— .1
Hotels	11.3	10.8	— .5
Hospitals	4.5	5.2	.7
Industrial	8.3	5.3	—3.
Office Buildings	10.3	13.7	3.4
Public Buildings	5.4	2.9	—2.5
Schools	10.7	12.5	1.8
Stores	1.9	2.	.1
Theatres	2.9	3.2	.3
Welfare, Y.M.C.A., etc.	.5	1.2	.7

Middle States

Type of Building	Requirements for New Buildings by 1926	1927	Percentage Change
Automotive	2.8	3.2	.4
Banks	3.4	2.6	— .8
Apartments	7.8	10.	2.2
Apartment Hotels	4.1	3.	—1.1
Clubs, Fraternal, etc.	5.3	5.	— .3
Community & Memorial	2.2	2.	— .2
Churches	4.5	6.	1.5
Dwellings (under $20,00)	2.8	2.	— .8
Dwellings ($20,000 to $50,000)	2.	2.4	.4
Dwellings (above $50,000)	1.6	1.1	— .5
Hotels	13.7	5.7	—8.
Hospitals	5.	4.9	— .1
Industrial	7.5	8.6	1.1
Office Buildings	12.1	16.6	4.5
Public Buildings	2.8	4.	1.2

Middle States (continued)

Type of Building	Requirements for New Buildings by Percentage 1926	1927	Change
Schools	13.5	13.6	.1
Stores	2.5	1.6	— .9
Theatres	5.7	5.8	.1
Welfare, Y.M.C.A., etc.	.7	1.9	1.2

Western States

Type of Building	Requirements for New Buildings by Percentage 1926	1927	Change
Automotive	2.3	3.6	1.3
Banks	3.2	2.	—1.2
Apartments	7.8	9.8	2.
Apartment Hotels	5.6	4.3	—1.3
Clubs, Fraternal, etc.	5.2	6.3	1.1
Community & Memorial	3.8	1.9	—1.9
Churches	4.4	6.2	1.8
Dwellings (under $20,000)	4.7	3.	—1.7
Dwellings ($20,000 to $50,000)	1.4	2.3	.9
Dwellings (over $50,000)	1.5	1.9	.4
Hotels	10.5	11.3	.8
Hospitals	7.6	3.9	—3.7
Industrial	3.8	2.9	— .9
Office Buildings	14.8	11.6	—3.2
Public Buildings	6.	9.6	3.6
Schools	10.5	13.9	3.4
Stores	2.3	2.1	— .2
Theatres	3.6	2.4	—1.2
Welfare, Y.M.C.A., etc.	1.	1.	

The next point of interest is to study the indications of this forecast in relation to building activity in various sections of the country in 1927 as compared to that of 1926. Reports received by The Architectural Forum have been carefully compared with last year's forecast figures and with the actual record of contracts let. This comparison shows that in the Northeastern States building activity will be approximately 10% less in 1927 than in 1926. This is closely in accordance with the average reduction of new construction volume expected throughout the country. In the North Atlantic States, which include the New York area, a similar average reduction in activity is expected. In the Southeastern States, it is anticipated that construction will be probably 20% to 25% less in 1927 than in 1926. The Southwestern States, however, promise a volume of new building approximately equal to that of last year. Figures received from the Middle Western States, including the Chicago district, show no anticipated reduction of activity—in fact, all indications point to a program probably 10% greater than that of 1926. The Western States are also to be consistent with the national reduction, showing activity about 10% less in 1927 than in 1926.

A comparison of anticipated new construction in various types of building for 1927 provides a basis for anticipating a number of changes both nationally and in various districts. The detailed comparison is found in the percentage tables presented with this article, but some of the outstanding features are as follows:

For the entire United States, new automotive buildings, bank buildings, club and fraternal buildings, community and memorial buildings, hospitals, commercial buildings, schools, stores, theatres, and welfare buildings will be constructed in approximately the same proportion to the total new construction as was the case in 1926. A considerable increase is anticipated in the building of apartment hotels, churches, and public buildings. Apartment buildings will represent a somewhat larger proportion of the new construction than in 1926.

The construction of new hotels promises to be probably 20% less than the actual figures of 1926. In forecasting hotel construction last year, The Architectural Forum's figure turned out to be considerably too high because it included a large number of projects which failed to materialize due to failure in financing programs. In Florida, for instance, many hotels which actually reached the foundation stage, were not completed because of the collapse of the boom. Similarly, many local "drives" failed because the project in mind was evidently too large—a point which should be carefully watched in relation to any new hotel project, and one which the hotel industry is watching carefully for 1927.

The Architectural Forum's estimate of hotel building shows a greater demand in the Northeastern States for 1927 than 1926; approximately the same in the North Atlantic States; a reduction of about 20% in the Southeastern States; approximately the same in the Southwestern States; less than half the demand in the Middle States (where a vast amount of new construction has been carried out), and approximately the same in the Western States. The comparative demand for new hotel buildings in the United States for 1927 is probably one-third less than that indicated for 1926.

A reduction of approximately 15% is expected in new construction contracts let for industrial buildings, such as factories and warehouses. Dwellings under $10,000, which made up approximately one billion dollars of last year's total, will probably show a 20% reduction in activity, while the construction of dwellings over $10,000 will be about 10% less.

The above deductions, as taken from the large number of individual reports received by The Architectural Forum in its Annual Survey, seem to be quite in accordance with changing trends of public demand for new buildings. The increased activity in apartment hotel building, for instance, is a definite reflection of a change in the mode of living which seeks convenience and comfort without the responsibilities of operating large individual dwellings. Thus, it is anticipated that there will be a definite increase in the number of cooperative apartment buildings, and no decrease in the volume of high class apartment construction.

To sum up the general impressions of this forecast, it is apparent that 1927 will be another year of considerable prosperity for the building industry and that economic conditions will provide both the demand and the means to add to the vast contribution to the nation's total of well build structures. The labor situation in the building trades promises

(Continued on page 78)

QUARRY EXPENSE TURNED INTO PROFIT

THIS is the story of how a quarry turned a debit item on its ledger into a public utility or how an expense became the basis for a profitable business. A few miles outside of Philadelphia is an extensive deposit of dolomite rock from which the Keasbey & Mattison Company, of Ambler, manufacturers of asbestos and magnesia products, obtains the raw material for the latter. The dolomite occurs close to the surface, being covered only by a few feet of loam and gravel, and is worked by stripping the superficial layers and taking out the dolomite by the usual open pit methods.

In the development of this quarry a considerable amount of water was encountered and constant pumping was required to prevent flooding of the lower part of the quarry. As operations were carried deeper and deeper, the amount of water steadily increased until the cost of pumping became a rather formidable item and, what was worse, promised to continue growing indefinitely as the work was continued. Workmen in the quarry soon discovered that the water was deliciously pure and cold. It flowed from the white rock walls in dozens of clear streams, each a spring on which neither the seasons nor occasional draughts seemed to have any noticeable effect in diminishing the flow.

But pure and refreshingly cold as it was this water was only a nuisance and expense, just as are similar water flows in hundreds of other quarries, until one day the thought occurred to somebody connected with the quarry management that here was an ideal water supply for the city of Ambler, which has a population of about 6000 people. Dr. R. V. Mattison, president of the Keasby & Mattison Company, took the matter up and arranged with the Ambler Spring Water Company to substitute this pure clear spring water for the supply which the city was then using.

While a pipe line was being laid from the quarry to Ambler, a distance of about three miles, and mains were being provided for distributing the water, systematic steps were taken at the quarry to develop the supply and protect it from pollution. A shaft was sunk from the bottom of the quarry, to serve as a well, and the water supply was tapped that formerly gushed through the quarry walls. This outlet was covered to protect it from dirt and pumps were installed to lift the

Well House and Suction Pipe at Bottom of Quarry water from the well and force it through pipes to Ambler.

Today, a handsome pumping station, built from Asbestos board and roofed with Ambler asbestos shingles stands beside the quarry, which is now dry at all times. The debit item has been wiped off the ledger and now the city of Ambler enjoys an ample supply of unusually pure water that is like nothing else than the flow from some hillside spring.

As the quarry is deepened, the well shaft is extended from time to time, but beyond this the system at the quarry requires practically no attention except to pump the water into the mains. All the details of distribution are attended to by the water company, which is a separate corporation with its own personnel.

In addition to supplying water for domestic use and fire protection in Ambler, the system meets all the demands of the large factories of the Keasby & Mattison Company and the Asbestos Shingle Slate & Sheathing Company, Ambler's two largest industries. And, incidentally, the coolness of this water has been worth large sums of money to these manufacturing companies, for two reasons: first, because that in the manufacture of magnesia the colder the water used for cooling the solutions from which the magnesia is precipitated, the larger will be the yield; and, second, because the use of the cold water for condensing purposes in the power plants insures greater economy of steam and saves a considerable quantity of coal in the course of a year.

"Tattle Tale" or "Charity Worker"?

As early as in the fourth grade we learned to despise the "tattle tale." There seemed always to be one in the class who could run to teacher or mother with excited, exaggerated tales of dire doings. Furthermore, our hatred for this type of person persists to our present age in life. The tattle tale and the squealer are unpopular, and rightly so. But there is one place where "squealing" is justified. That place is against the dangerous man. Every employee, from the lowest paid to the grade of assistant foreman, should be made to realize that it is a duty, not only to the employer but to their fellow workers and themselves, to "tell on" the dangerous man.

It is impossible to gather together, for any industrial purpose, ten or more men and not have at least one who is more careless than the rest. And it is this careless one, the perpetrator of thoughtless or malicious acts, that is the heaviest contributor to accidents and injuries. Reporting such carelessness or "practical jokes" to the superintendent or foreman is not "squealing." Instead of being a "tattle tale" the reporter is a charity worker in the interest of all his associates.

Pumping station which stands beside the quarry

HOUSE ORGAN PAYS STEWART SAND COMPANY

The Stewart Sand Company, of Kansas City, Missouri, has over one million dollars invested in equipment alone. Sixty-five big trucks are on Kansas City district streets at one time. Located at strategic points in the city are five yards. Kansas City newspaper circulations reach, say, two hundred thousand. Investigation shows, however, that approximately three thousand is the maximum number to merchandise Stewart service and products to. What advertising will the company use?

Some two years ago, the company decided direct mail advertising was logically its type. Why address a message to two hundred thousand or more, when three thousand were all that mattered? In April, 1925, accordingly, the company launched a house organ, handled by a house organ specialist of Kansas City, Charles W. Stanbrough, whose official title is editor. The little house organ, nine inches by six inches, eight pages, was called, "Better Building."

The Stewart Sand Company was over thirty years old, and long had been a big factor in the sand trade. At this time, distribution by it was getting under way for "ready for the job" materials, Blue Diamond mortar and plaster. It is worth putting down, as one of the sales obstacles the house organ faced, that there was considerable opposition among craftsmen of Kansas City, especially the younger element, against products with a lime base. There was a union prejudice on the subject. With this illusion to a fundamental selling problem, let's get back to the analysis and the house organ constructed out of it, in the words of Stanbrough.

"We investigated thoroughly," he related, "to determine just exactly those who directly or indirectly influenced the purchase of the materials we sold. On the basis of this, we built up a list of about three thousand names. On it were architects, contractors, builders, officers of building and loan associations (we included the entire officer personnel way through the board of directors of each association) and officers of any organization having to do with the purchase of building materials in any way. On the list, too, were sand dealers in the Kansas City territory outside the city.

"Our research showed, as we proceeded, that the architect and builder were the most important factors by far—that the consumer seldom had much to do with the actual purchase.

"We adopted the house organ form for a number of reasons. To begin with, there was dignity and impressiveness to it. Anyone can get out a single mailing piece, a broadside, but it takes a real business to go on issuing a regular publication month after month. Further, a house organ would enable us to handle expertly special problems.

"For example, take the opposition of union labor. We started a series in Better Building entitled, "Master Craftsmen." An editorial introduction to this explained that, believing that plastering is an art and that the importance of this branch of the construction industry deserves attention, we are going to try to introduce to the public the master craftsmen of Kansas City—men who were outstanding as to their achievements and whose work reflects the age old—yet ever new—true 'art of plastering.'

"We run one of these a month—a snapshot of the man, a brief biography, and always including what the subject thinks of Blue Diamond plaster.

"For example, in our October, 1926, issue, we featured Frank Stutzman. We concluded the little sketch with a paragraph running like this—

"Mr. Stutzman has been a staunch advocate of Blue Diamond Plaster from the start. Asked to express his ideas on Blue Diamond, he said, 'I can heartily endorse Blue Diamond Lime Plaster, and I wish I would never have to use anything else in the future. There is absolutely no waste to it, and it is much easier to work. As I see it, hard wall plaster means hard work—while Blue Diamond plaster is as easy to "push" as finish putty. Lime plaster has excellent acoustic qualities and I believe that as its advantages become better known its use will greatly increase.' "

"Officials of the union are on our mailing list to receive the house organ. We have gone thoroughly into the whole subject with union labor, with the result that, sometime ago, a resolution commending our product, and favoring it, was passed.

"We have a little column, Architect's Notes, and another, Contractor's Notes. The titles indicate our purpose with these—to have something of special interest and appeal for classes decidedly important among our prospective customers.

"We give much publicity to construction work in which our products are used. For example, in the October issue already mentioned, we have on page seven half tones of four recently completed buildings. One is a theatre building. There is the information that Ed. Grogger is the owner and builder, from private plans. Then, all caps, we say, 'Blue Diamond Plaster and Brick Mortar used.'

"Another building is the H. D. Lee Company, garage on Wyandotte. That J. C. Sunderland was the architect and Burt Dyche, the brick contractor is stated. Then comes, as usual, 'Blue Diamond Mortar and Classified Sand used.' We use a great deal of such material, and are positive it is of great value for our purpose. All types of buildings are thus given mention. For example, this same October issue contains a cut of the garbage reduction plant of the Pan American Feed Company.

"The cover of the issue is a handsome residence, the owner and architect for which were the same. Names are given.

"Another phase of Better Building is what I might call personnel promotion. We strive to acquaint the three thousand list with the human side of the Stewart Sand Company. On our editorial page, below the masthead, we have the heading, 'Our Folks Who Want to Know and Serve You.' Then there is a list, in bold face type, beginning with Mr. John Prince, our president, E. L. Kirkham, sales manager, and others. When Mr. Henry J. Gish became the new manager of the Blue Diamond department, we gave the entire inner front cover to an introduction, with a half tone of Mr. Gish.

"Everybody in the organization, in a way of speaking, gets attention sometime—that is our aim. Here is a column in one issue, beneath the heading, 'He's More Than a Truck Driver.' We emphasize the fact that our drivers are more than truck drivers—they are managers of a seven thousand dollar business, the investment in the truck they have charge of. We tell our readers that the Stewart Sand Company feels that a man to be in direct charge of an investment of six thousand to seven thousand dollars must be a very worthy employee—not 'just a truck driver.'

"In another issue we introduced with half tones what we called 'A pair of Queens.' These were Miss Crozier, our order clerk, and Miss Grove, her assistant. Then, completing the page, we introduced Jay F. Summerville, the 'sand-man,' who represents us out in the territory.

"Plant pictures have been used from time to time."

The house organ has been the advertising promotion put behind the Stewart Sand Company's Blue Diamond products. Very gratifying progress has been made in the introduction of these, while the steady sand business has gone along nicely, too. The company has had numerous manifestations that the little house organ is received cordially in hundreds and hundreds of offices. It is considered a full-fledged merchandising success.

All of which has ensued from a careful analysis of the company's advertising arithmetic—followed by action based upon it. First, the people to be reached were determined accurately. Then the economical, forceful way was developed to perform the job of reaching. In this, the house organ "came through."

Lubrication of Machinery

Lubrication is a subject that is very little understood. It is true, of course, that the matter of lubrication is just now coming in for a greater degree of attention and study than it has hitherto received; but the field is immense and missionary work needs always to be carried on, that new converts may be won and backsliding prevented.

One of the far reaching steps toward improvement in general industrial lubrication is the growing realization on the part of many engineers and foremen that machinery can have too much oil. In years past, electrical equipment manufacturers, when installing a motor, were impressive in their instructions regarding lubrication. They pointed out the liability of forgetfulness and the consequences that would ensue. Under those instructions the maintenance men considered a liberal application of oil a necessity, and having been told by the manufacturer to oil the motor he proceeded to oil it. The result was oil soaked windings and coils, filmy brushes, and generally deplorable conditions. The fact that maintenance men are realizing that too much oil can be as detrimental as too little oil, augurs well for the life and service of equipment now installed.

Another step forward in the field of lubrication is the increasing knowledge that a single kind of oil will not suffice for all purposes. That oil is not just oil is information many engineers are learning rapidly and at considerable cost. This knowledge once well grounded will do much to further the service of machinery. In the matter of transmission equipment, in all the four classes of bearings, high-speed high-pressure, high-speed low pressure, medium-speed medium-pressure, and special bearings, there is needed a totally different lubricant. Nothing could be more impractical or unscientific than the idea that a single grade of oil would suffice as a lubricant for all classes of bearings. An oil with sufficient viscosity for use on a huge boring mill, as an example, could not be successfully employed on small high-speed machinery. Nor will the oil rightfully belonging to a bearing on a 9-inch lathe properly lubricate the bearings in the shaft hangers.

When a lubricant is too viscid, it actually retards the motion of the metal (by reason of its high internal friction) notwithstanding that it lubricates the moving parts. By the same token, an oil that does not possess sufficient viscosity (usually termed a "thin" oil) is unable to withstand high-pressure with the result that most of it will be squeezed out of the bearings.

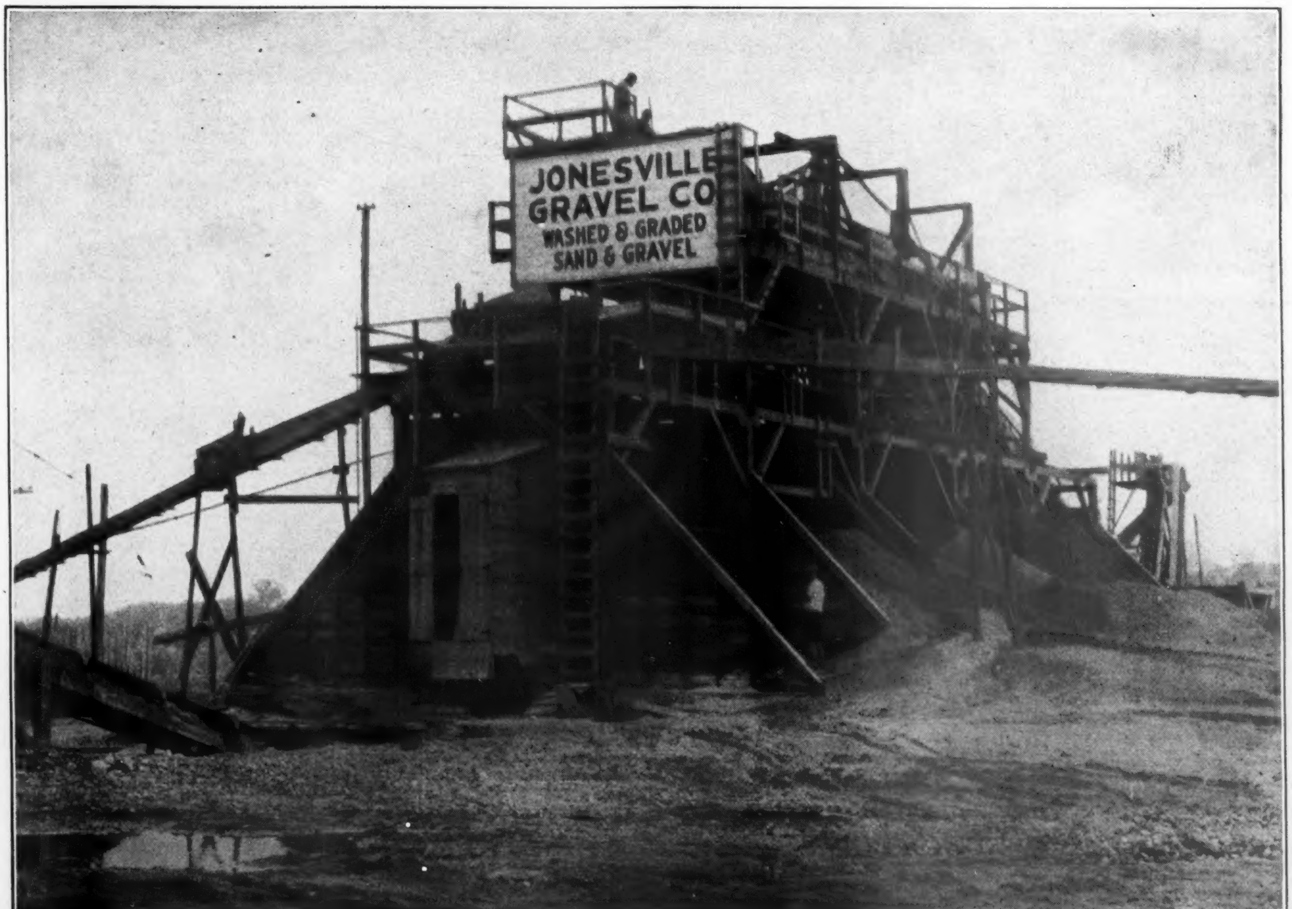
It should take only a few facts of this sort to bring home the realization of the importance of lubrication and to prove that a qualified lubricating engineer (usually obtainable from a reliable oil company at little or no cost) should be called in to make periodic check-ups on existing lubricating practice. Such simple and inexpensive procedure would frequently reveal channels of waste and methods for astonishing economy.

MINOR ADJUSTMENTS INCREASE PRODUCTION FOR JONESVILLE SAND AND GRAVEL COMPANY

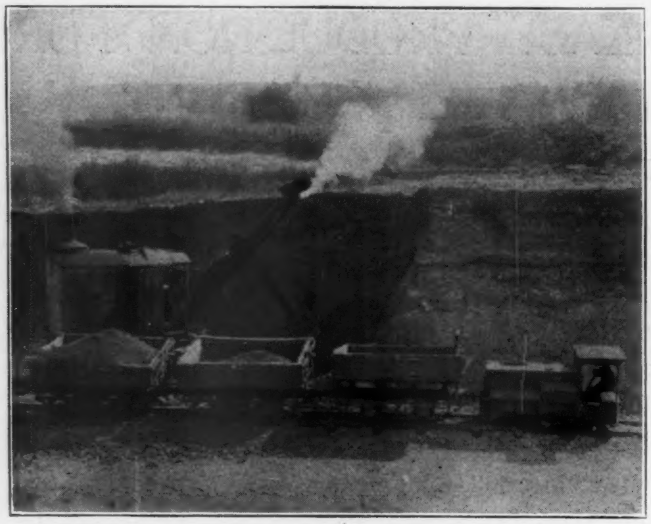
By E. D. Roberts

DURING the glacial period, many thousands of years ago, Michigan was covered with an immense glacier which was part of the ice sheet which came down from the northern regions. The scouring action of this glacier produced vast quantities of sand and gravel of varying fineness and quality. This sand and gravel, together with any soil or clay that had been picked up, was carried along with the glacier and deposited wherever the glacier terminated, that is so far as the glacier was concerned. As the glacier melted, water was produced which found its way to the sea by various routes and at various velocities. If the velocity of the water was great, a large part of the material, carried by the glacier, would be moved past the end of the glacier, to be deposited, partially or the whole, whenever the velocity of the water slackened. At times, previously deposited material would form a dam at the terminus of the glacier and, as the ice melted, the sand, gravel or other material would be deposited in the pond formed at that point. Sometimes, these deposits would be subjected to the washing action of streams at some later date. It can therefore be seen that the varying conditions which existed when the loose material was deposited has resulted in sand and gravel deposits in central Michigan of different characters and qualities. Very few are as good as that of the Jonesville Sand and Gravel Company.

All of these Michigan deposits contain more or less light soft rock commonly called "float". This "float" is very annoying where the aggregates are used for concrete as it comes to the top during the tamping, and after the concrete is subjected to wear for a short time, these soft pieces wear out leaving holes which hasten the deterioration of the road. The concrete specifications of Michigan have prohibited the use of aggregates containing more than a certain percentage of this objectionable stone. The product of the Jonesville Company has been shown to contain but one-half of the percentage of soft or "float" material permitted by the Michigan State Highway concrete specifications. This has been made possible by additions made to the plant during the past summer which will be explained in detail later in the article.



Plant View from Southwest



Excavating Sand and Gravel

The present plant has been in operation for three years and was built at a small cost and requires but a small force to operate. Previously concrete materials were being produced with a safe margin of profit, but conditions were not fully as good as the company desired. Therefore, last June a new man, Mr. H. Dieterman, was placed in charge as plant superintendent. Soon after taking charge, Mr. Dieterman, on looking the plant over found that the production depended upon the shipping facilities and not on production operations. Investigation showed that the shipping belt would not carry a full load due to a wet condition of the washed material. He therefore installed a larger belt and reduced the slope angle, thereby doubling the capacity of the plant. There are many other plants that have some weak spot in the process which creates a bottle neck in the production and if a profit is now being made, the owner may be satisfied that if he would make a searching investigation or call in someone who would investigate each step in the production, slight changes or additions might be found advisable that would increase this profit. Many operators have found that minor changes have brought about such a marked increase in production that a new plant was not required to meet the increased demands for materials resulting from the normal increase in business.

As the excavated material of this deposit contains some silt and a large percentage of fine sand, both of which are carried off in the wash water, special treatment of the waste water is required in order that a nearby lake will not be filled.

The deposit worked by the Jonesville Sand and Gravel Company comprises forty acres located alongside the New York Central Railroad tracks, about a mile south of Jonesville, at the point where the paved state highway crosses the railroad. The

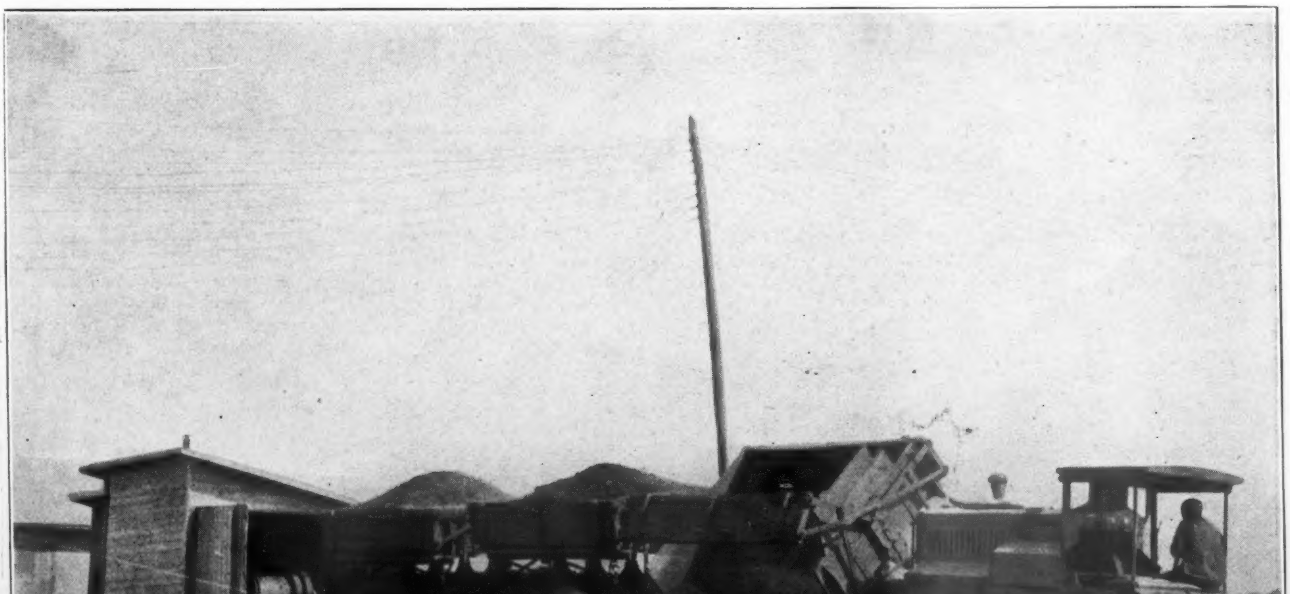
Close-up Showing Picking Box (where 2 men are standing) crusher and bucket elevator Back to Number 1 Belt company can therefore ship by either rail or trucks, and most of the material is used for concrete road construction work throughout central Michigan. One corner of the deposit touches a lake, the larger portion of which adjoins adjacent property. Water for washing the material is secured from this lake but the disposal of the washwater is somewhat complicated as the large percentage of solids carried by the water would settle in the lake and soon fill it. As lakes are valuable in this region for summer homesites and, in order to keep from having a damage suit on their hands, special precautions have therefore been taken with this waste water. It is led into a sump located close to the washing plant and when the sump is nearly full, a 6-inch Morse sand pump removes the sand and silt and forces it through a 600-foot pipe line to a settling area and by taking most of the water out of the material in the first sump, very little care has to be taken in the final settling area.

In the deposit two to three feet of earth is found on top of the gravel and forty feet of gravel and sand is found above the water level of the drainage. The soil is removed by a steam-shovel and trucks during the winter months, thereby enabling the company to operate with only one excavator and at the same time be able to remove the stripping economically. An Erie full revolving steam-shovel, equipped with wide wheels and a ¾-yard bucket excavates the gravel from the bank, the top twenty feet of the dry material is at present being removed. Later the next twenty feet will be excavated by this steam-shovel after which plans call for the installation of a floating dredge.

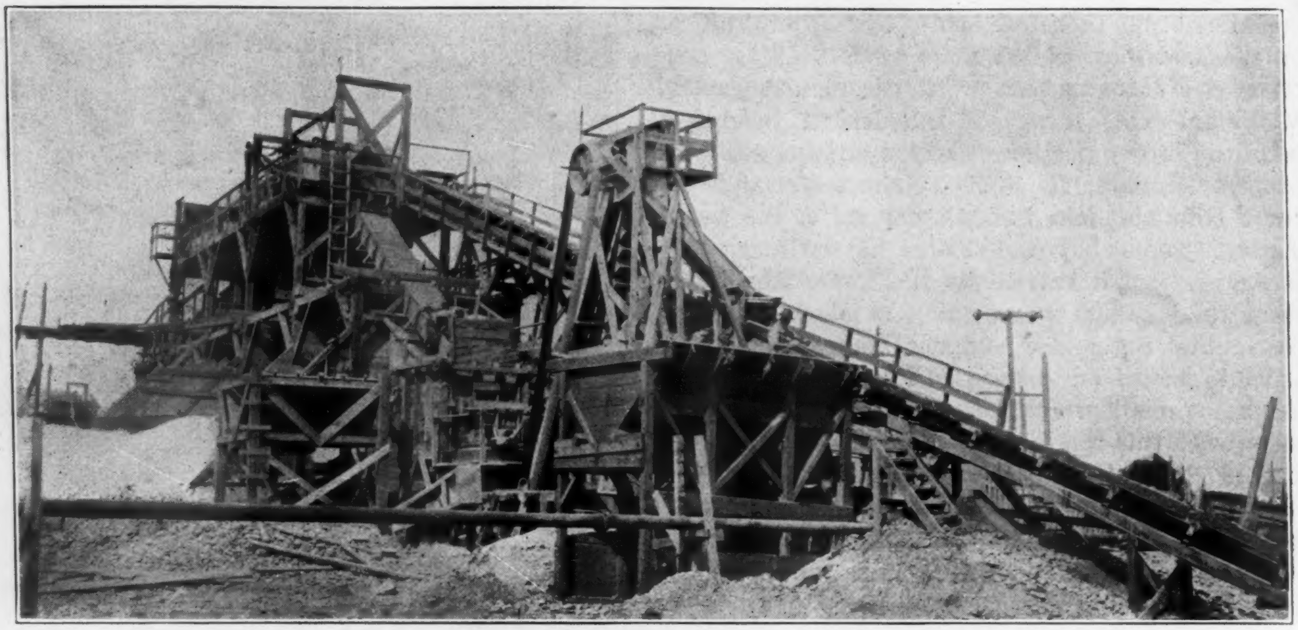
Close-up of New Crusher

Four-yard Western side dump cars are used to transport the excavated material from the steam-shovel to the receiving hopper. Three cars make up a train which is hauled by a 4-ton Plymouth gasoline locomotive. When the train reaches the end of the pit an inclined track, leading to the hopper, is provided up which the train is drawn by a Flory hoist and cable. Two of these trains of cars are operated continuously by two locomotives so that there is very little idle time either at the shovel or at the incline.

The train of cars is pulled past the receiving hopper so that the cars may be dumped as the train coasts down hill and as the track has been given



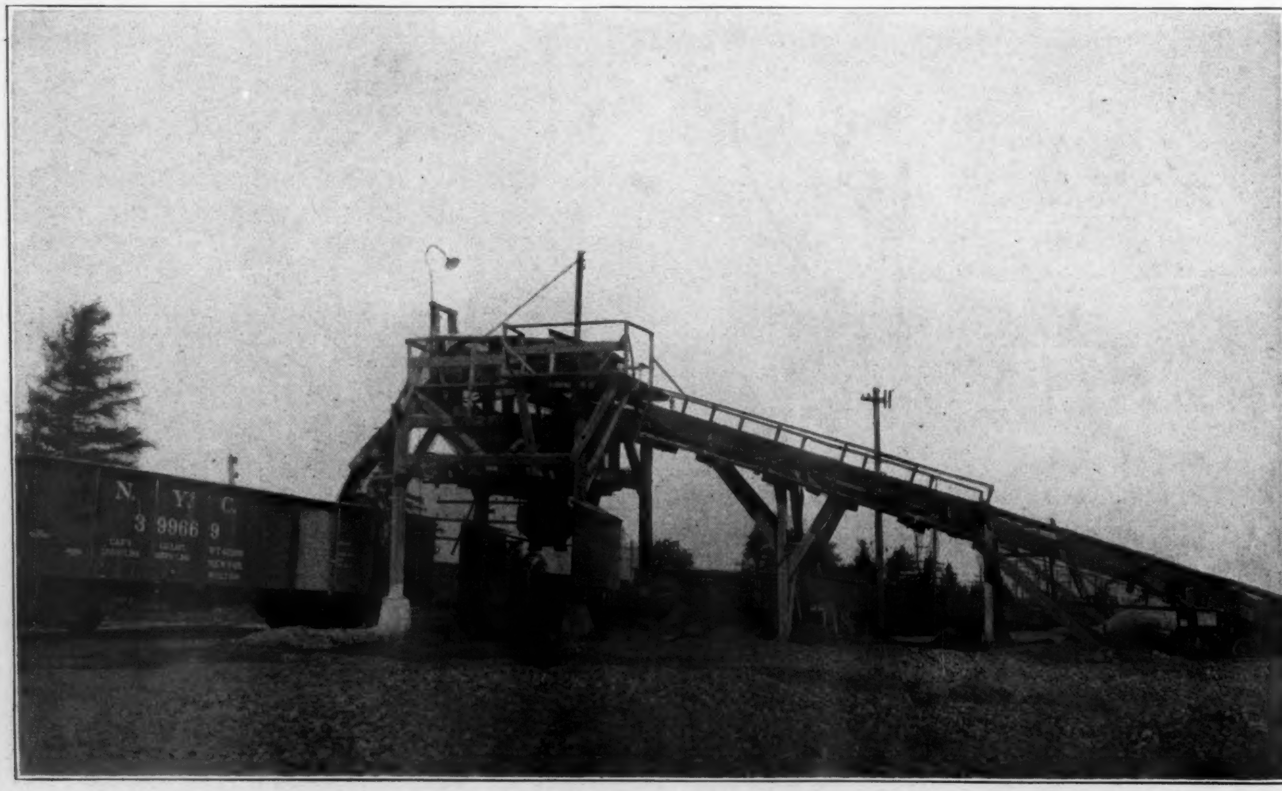
Dumping Gravel Into Receiving Hopper



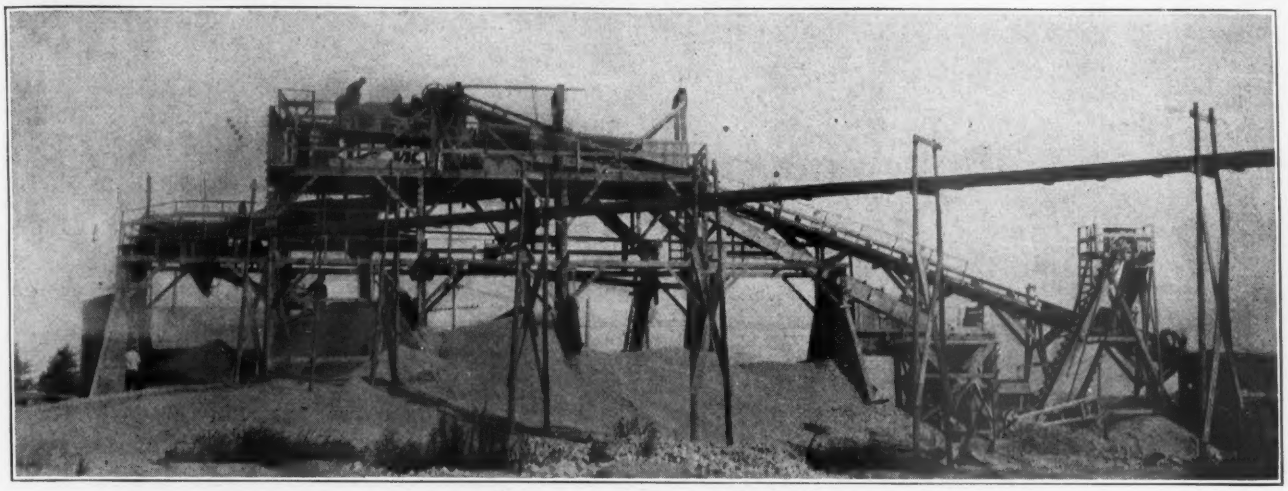
Elevation of Plant from Near Receiving Hopper

a tilt towards the hopper which causes the cars to lean to that side, the dumping can be accomplished without the train coming to a dead stop. Grizzly bars, placed over the top of the concrete receiving hopper, remove any stray boulders. A Telsmith plate feeder fastened to the bottom of this hopper, withdraws the sand and gravel from the hopper and discharges it on to a 24-inch inclined conveyor belt. This conveyor, with a Goodrich belt, traveling on Stephens-Adamson ball bearing troughing rolls, discharges its load into a preliminary washing box where two streams of water, furnished by two 6-inch Union centrifugal pumps, are jetted into the material and carry off the soil and fine silt. The sand and gravel cascade into the Telsmith sizing screen, which is 48 inches in diameter and 20 feet long, where a stream of water from a 4-inch Union centrifugal pump gives the material a further washing.

The sand, together with the water, passes through a sand jacket and thence to the Telsmith dewaterers where torpedo, or concrete sand, and mason's sand is produced, going through chutes to the proper compartments below. The water, together with the fine sand, joins the water discharged from the preliminary washing box and is



South Elevation of Plant, Loading Out Gravel



General View of Loading Station

flumed to the sump, to be finally disposed of by a 6-inch Morse sand pump in the manner previously mentioned. The desired grades of gravel are produced by a revolving screen and are discharged below into the proper compartments.

The oversize material from the revolving screen falls into a chute leading to a picking box. Formerly this chute led directly to the number 8-A Telsmith jaw crusher, and picking out the "float" material was done on the shipping belt. However, this method for the removal of the soft rock was unsatisfactory due to the fact that with the large amount of swiftly moving material passing over the belt the inspector's eyes became blurred. Therefore, the installation of the present sorting box has solved the difficulty, because now the material from the sizing screen is allowed to accumulate in a box while the men are removing the soft pieces out of the rocks in the box compartment farther down the incline. When all the objectionable pieces have been removed, the charge in the sorting box is allowed to fall into the jaw crusher by lifting a gate. When the sorting compartment is emptied, the gate is lowered and the entrance gate raised, allowing the rock that has accumulated in the upper box to pass into the sorting compartment. By closing the entrance gate additional rock is prevented from entering the sorting box and the sorting process is continued. By this method of eliminating the "float", the Jonesville Gravel Company has been able to deliver aggregate which contains but one-half of the objectionable material permitted by the Michigan State Highway requirements for concrete.

A View of the Sump

Plant from point opposite steam shovel

A bucket elevator receives the discharge from the jaw crusher and discharges it onto the same inclined belt which brings the raw material from the concrete receiving hopper. This number one belt carries the crushed material, together with the raw material, up to the preliminary washing box, after which it goes to the sizing screen for classification. The sizing screens, washers, etc., have been placed on an elevated trestle work, the bents of which being used to support bulkheads forming partitions which divide the various grades of sand and gravel. These bulkheads extend far enough to the sides to meet the natural slope of the material and, in this way, provide a large storage space at little expense. In case a compartment should fill faster than the shipping requirements of that particular grade, the sand or gravel is then hauled out at right angles to the axis of the trestle.

A tunnel has been constructed underneath the ground and on the center line of the trestle. In the top of this tunnel, slide gates have been provided through which the sand or gravel is permitted to fall onto a horizontal 20-inch conveyor belt, which operates throughout the length of the tunnel. As originally constructed, this 20-inch belt discharged onto another 20-inch belt which carried the load up to the loading platform. However, when starting to draw the material from any compartment, considerable water came through with the first material, which, in the case of sand made it practically impossible for the inclined belt to function, except at very light load. Therefore, Mr. Dieterman has remedied this difficulty by replacing the 20-inch belt with one 24 inches wide and at the same time changed its slope angle. As a result of this change, the capacity of the plant has been doubled.

The inclined 24-inch shipping belt discharges directly into railroad cars spotted on the loading track. A hoist and cable pull the train of cars, to be loaded, downhill past the loading platform, and when desired, the loading belt can discharge into a bin underneath the loading platform. This bin is hoppered and fitted with two compartments to which are attached batchers so that batched material for highway construction can be delivered at the plant.

The largest motor used in the plant is a General Electric of 75 horse power, which operates the Morse sand pump. The next largest motor is a Howell 30 horse power on the gyratory crusher and the bucket elevator which carries the crusher discharge up to the number 1 belt. Individual motors are chiefly used on each unit.

A Few Points on Belting

When ordering belts it is well to remember that the order should state the exact length around the pulleys, grade of material desired and whether there is required single, double, or three-ply. In ordering for stock the usual manner is to order a "roll" which consists of about 400 feet single or 250 feet double. Stock orders may be given, however, for any specified footage ranging upward from 100 feet.

There are three ways in which transmission belts are shipped; endless, square end, and laps extra. Ordinarily, manufacturers make a sufficient allowance for a lap when the order specifies "square end." If the belt is ordered endless it will be so made at the factory. If ordered laps extra, the laps are prepared and made ready for cementing before given shipment.

The superintendents and engineers of yesterday were wont to consider "a belt a belt." That idea is now as thoroughly obsolete as the pick and shovel, the great majority realizing that as in everything else so in belts we "get what we pay for." A good belt may cost twice as much as a poor belt, but those looking for service and satisfactory performance never waver. It is the good belt, regardless of first cost, that the experienced purchased buys, since he knows inital cost to be a misleading medium for the measurement of quality.

Many belt users are not prepared to make exhaustive tests to the end of determining which belt is the better and more economical for given conditions. In such cases the purchasers must throw the responsibility for service on the manufacturer. And this condition permits consideration of only those firms whose reputation for fair dealing and quality products has been firmly established.

Ice as a Bending Compound

The United States Bureau of Standards has recently found that in making coils or spirals of small-diameter brass or copper tubing, ice lends itself to the work very satisfactorily. The tube to be bent is first filled with water which is then frozen by being packed in salt and ice. After freezing, the tube, filled with ice is bent into the desired shape. The ice then melts and runs out, leaving the tube clean, shapely, and empty.

RECENT HIGHWAY RESEARCH DEVELOPMENTS

By E. F. Kelley

RESEARCH, as applied to highway problems, has developed almost within the last decade, from a minor position to one of recognized importance. The reasons for this are obvious and have been stated so frequently that they need no repetition here.

The selection of that type of construction which, for the particular conditions involved, will result in the most efficient utilization of available funds and materials requires the proper evaluation of numerous variables, many of which are at present unknown quantities. The pressing need for accurate data as a basis for the scientific evaluation of these variables is receiving ever increasing recognition with the result that research programs are now being prosecuted by numerous agencies and the aggregate number of research projects under way is surprisingly large.

With so many investigators in the field, releases of valuable data are of frequent occurrence and it is impossible to review here all of the many recent developments of importance. Rather it is the intention to present a brief summary of the significant results developed by a few of the researches in which the U. S. Bureau of Public Roads has been directly concerned.

Motor Truck Impact

A primary requisite for the design and maintenance of highway structures is an accurate knowledge of the destructive forces to which they may be subjected. At the present time the motor truck is recognized as one of the more important of these destructive agencies. For a number of years the Bureau of Public Roads has been concerned in a series of investigations which have had for their object the determination of the impact forces delivered to road surfaces and bridge structures by motor trucks, the factors influencing the magnitude of these forces, and the effect of these forces on the structures involved.

One series of tests, conducted cooperatively by the Bureau of Public Roads, the Society of Automotive Engineers and the Rubber Association of America, was undertaken to determine the influence of type and condition of tires, speed of vehicles, roughness of the road surface and certain other variables, on motor truck impact. The investigational program has not been completed but some of the results are now available.

The impact road reaction depends on the four major variables—wheel load, truck speed, tire equipment and road roughness. Other variables exert some influence but, in general, these four are the important ones. An increase in load, speed, or roughness, or a decrease in the cushioning qualities of the tires, results in increased impact reactions.

Two Component Forces

The force of the blow which a truck wheel delivers to a road surface is made up of two component forces. One of these is due to the acceleration or deceleration of the unsprung truck weight (that is, the weight of the parts below and not supported by the truck spring), and the other is due to the spring pressure on the axle at the instant of impact.

For normal operating conditions the unsprung component is the major quantity and this is especially so in the case of solidtire equipment. Many of the tests with solid tires showed the unsprung component to be as much as 90 per cent of the total reaction at ordinary operating speeds. From this it may be inferred that cushioning devices *above* the truck springs should have relatively little effect on the road reaction, although the riding qualities may be appreciably affected thereby.

The magnitude of the impact force is dependent upon the type and condition of the tire. Worn-out solid, new solid, new cushion and pneumatic tires, in the order named, produce impacts of decreasing magnitude. For instance, under certain test conditions in which 2-ton trucks were operated over artificial obstructions at a speed of 12 miles per hour, the measured impact reactions, expressed as percentages of the static load, were as follows: Worn-out solid tires, 680 per cent; new solid tires, 370 per cent; new cushion tires, 240 per cent; pneumatic tires, 140 per cent.

Thick Tire Rubber Reduces Impact

Increasing the thickness of the tire rubber has been shown to have a marked effect in reducing impact. An appreciable variation in the cross sectional rubber, or breaks in its continuity, result in heavy and repeated impacts and this leads to the recommendation that dual tires be mounted with the tread designs staggered. For the conditions under which these tests were conducted maximum impact reactions occurred at critical speeds of between 12 and 15 miles per hour. It will be of interest to those who are accustomed to think of impact as a percentage of the static load to note that, while the impact force increases with increase in the wheel load, the percentage of impact, or the ratio of impact to static load, actually decreases. This may be attributed largely to the major effect of the unsprung weight, already mentioned, and the fact that the ratio of unsprung to total weight decreases with increasing gross loads.

Study of Road Roughness

One of the most interesting phases of this investigation has been the preliminary study of the effect of road roughness. Test trucks were operated on two pavements having a marked difference in surface roughness and the results show that poor tire equipment may be exceptionally severe even on a smooth road while good tire equipment considerably reduces the impact effect on a rough road. For instance, for a certain test condition in which 2-ton trucks loaded to rated tire capacity were operated at a speed of 12 miles per hour, the impact reaction which occurred on an average of once in every 10 feet of road length showed the following relationship: On the smooth road this reaction exceeded the static load by 5 per cent for pneumatic tires and 45 per cent for worn-out solid tires; on the rough road the excess over the static load was 40 per cent for pneumatic tires and 270 per cent for worn-out solid tires. The advantage of smooth pavements aside from considerations of riding qualities, is thus emphasized.

To provide data which may serve as a basis for design and for the intelligent drafting of motor vehicle regulations, this portion of the investigation has been extended to determine the impacts which variations in load, speed and tire equipment may be expected to produce on pavements of various types and degrees of roughness. Another interesting phase of the impact investigation was the comparison of the reactions produced by 4- and 6-wheel trucks. This indicated that the unsprung components of the impacts produced by a 6-wheel truck are approximately one-half those produced by a 4-wheel truck carrying the same load. These results are a corroboration of previous tests pavement by a 6-wheel truck are approximately one-half as great as those produced by a 4-wheel truck carrying one-half as great as those produced by a 4-wheel truck carrying the same which showed that the resultant stresses produced in a concrete load. The significance of these results lies in their indication that vehicle development may make possible the truck transport of greatly increased gross weights without a corresponding increase in the destructive effect on pavements.

Load Limitation Requires Knowledge

The development of the data which will permit us to forecast with some accuracy the impact forces which may be developed under certain conditions does not, of itself, afford a solution of the whole problem since our primary object is scientific pavement design. The design of new construction and the limitation of loads on existing pavements to those which they can support with safety requires a knowledge of the stresses produced in road surfaces by impact forces. Considerable information along this line has already been developed, but much still remains to be done.

In a previous investigation of the stresses due to impact in concrete pavements it was noted that unusually high unit stresses were developed. At elastic failure of the concrete under impact loads, tensile stresses were recorded which were at least twice as great as would ordinarily be expected to produce failure under static load. These results *seemed* to indicate that it might be permissible to use higher unit stresses in designing for impact forces than would be safe for static loads.

Stress Information Is Important

The importance of securing conclusive evidence on this question, will be recognized and such evidence has been made available in the results of a cooperative investigation by Johns Hopkins University and the Bureau of Public Roads. These tests, while corroborating the results of the earlier investigation, have shown conclusively that higher unit stresses than would be used for static load design may *not* be used with safety in designing for impact loads.

Concrete beams subjected to static load showed a considerably lower modulus of rupture than exactly similar beams subjected to successive impacts of increasing magnitude when each of these impacts was applied *but once.* Under these conditions the beams were capable of withstanding greater elastic deformation under impact than they were under static load.

However, when the beams were subjected to repeated applications of impacts of the same magnitude, it was found that the greatest impacts which they could withstand without failure were those which produced a tensile stress equal to about 55 per cent of the static modulus of rupture. Other investigations of the fatigue limit under static load have shown that concrete may be safely subjected to an indefinite number of times to a stress equal to about 55 per cent of its ultimate strength. From this it may be concluded that the behavior of concrete, when considered from the standpoint of fatigue limit, is very similar under both impact and static forces.

Investigation of Bridge Impact

The discussion of motor truck impact would not be complete without reference to the investigation of impact in highway bridges which for several years has been carried on cooperatively by the Iowa Engineering Experiment Station, the Iowa Highway Commission and the Bureau of Public Roads.

For years the question of the proper impact allowance for which provision should be made in the design of highway bridges has been the subject of lively discussion among bridge engineers. No scientific data, applicable to modern loadings, has been available and of all the the impact formulas which have been developed and used, none has been founded upon a more logical basis than the personal opinion of its author.

The bridge impact investigation was undertaken to throw some light on this question and, though still far from complete, it has demonstrated conclusively that impact stresses of considerable intensiyt are produced in bridge structures by the passage of motor trucks. As in the case of the motor truck impact tests previously discussed, this investigation has shown that the impact increment of stress is due very largely to the unsprung weight of the truck and, therefore, that the percentage of impact decreases with increases in the total truck load.

Tests Confined to Floor Systems

The tests have been confined largely to the floor systems of bridges. Floorbeams and stringers supporting concrete floors have been shown to be subject to an impact increment of from 15 to 100 per cent of the static stress, depending on the condition of the floor as regards roughness or obstructions. Even higher percentages of impact have been observed in the floor systems of timber-floored bridges. It may be remarked that there are still no data available which may serve as a logical basis for a nimpact formula to be applied in the design of truss members.

The importance of the motor truck in highway transport is a measure of its importance in the highway research program. The data yielded by past researches are very largely qualitative and, to a great extent, we must ook to the future for the quantitative results which are so necessary. The unsolved problem of major importance is the accurate coordination of the truck and the pavement.

Investigation of Thin Paving Brick

The increase, during the past few years, in shipments of paving brick of less than 3 inches in thickness has reflected the growing opinion among engineers that the thinner brick may be adequate for pavement construction. The statistics submitted to the Permanent Committee on Paving Brick Simplification of the Department of Commerce show that the shipments of 2½-inch plain wirecut brick amounted in 1923 to 2.7 per cent, in 1924 to 4.4 per cent, and in 1925 to 8.9 per cent of the total shipments of vitrified paving brick. In 1925 the shipments of two of the four sizes recognized as standard fell below those of 2½-inch brick.

In order to secure a measure of the comparative value of paving brick of various depths, particularly those 3 inches or less in depth, the Bureau of Public Roads has conducted an extensive investigation, the results of which have been reported recently. The investigation included an accelerated traffic test on brick wearing surfaces of varying thicknesses, supplemented by a field survey of several million square yeards of thin brick pavements which had been in use a sufficient length of time to demonstrate their serviceability.

The Accelerated Traffic Test

In the accelerated traffic test it was desired to eliminate all variables due to base construction and to test the brick as a wearing surface on an adequate foundation. For this purpose there was available a reinforced concrete circular track 6 inches thick, 13 feet wide and about 1/10 mile in circumference, which had been used in previous tests. On this base were laid the ten test sections which included five thicknesses of brick (2, 2½, 3, 3½ and 4 inch) and two types of bedding course (plain sand and cement-sand). The joints in the brick surface were filled with asphalt. These pavement sections were subjected to an accelerated traffic test of 62,200 passages of loaded motor trucks, the loads on these trucks ranging from 3 to 7½ tons. A total of approximately 630,000 tons of truck traffic was applied to each section during the period of thes test and of this approximately one-third was carried on trucks equipped with heavy tire chains. All of this traffic was concentrated in two 30-inch lanes or wheel paths. Based on traffic surveys, it is estimated that this accelerated traffic was equivalent to the average actual traffic of 3 to 7½-ton trucks on the highway system of Cook County, Illinois, during a period of 18 years. The behavior of the test sections was compared largely on the basis of the number of brick broken during the progress of the test. It should be understood, however, that while transverse breakage was taken as a criterion of service, this breakage did not materially affect the actual serviceability of the test sections.

Conclusions from the Test

The most important conclusion derived from this investigation is that 2½-inch brick of the quality used in the tests, when supported by an adequate base, are satisfactory for pavements carrying heavy traffic. Also that 2-inch brick of similar quality and properly supported are adequate for pavements carrying the lighter types of traffic.

The resistance to breakage of the 2½-inch brick was remarkable and, for the particular conditions of this test, was only slightly less than that of the thicker brick. In the 30-inch wheel strips which carried the traffic loads, only fifteen bricks were broken in the sections of 2½-inch brick. One brick was broken in the 3-inch sections, six in the 3½-inch sections, and three in the 4-inch sections. Three hundred ninety-eight bricks were broken in the 2-inch sections.

The Bates Road test in Illinois and previous investigations by the Bureau of Public Roads have shown that bituminous-filled brick tops cannot be expected to add materially to the beam strengths of pavement bases. This seems obvious, since a flexible wearing surface which has no bond with the base can scarcely be expected to add to its structural strength. Therefore, it has been concluded that the base should be as heavy for one thickness of brick as for another. The field survey has shown that, in practice, changes in base thickness are seldom made to compensate for changes in brick thickness.

Must Adapt Base to Load

The accelerated traffic test was designed to test the brick as a wearing surface and the foundation was more than adequate for the loads to which it was subjected. It is emphasized that if failures of brick pavements are to be avoided the base course must be designed to carry the loads. The base must be stable in itself, regardless of the thickness of the brick surface. The accelerated test showed very definitely that the plain-sand bedding course is superior to the cement-sand bedding. In the 2-inch brick sections the breakage which occurred on the plain-sand bed was less than one-half that which occurred on the cement-sand bed.

Cobbling or rounding of the edges of individual brick was shown to be due almost entirely to the use of none-skid tire chains. The amount of cobbling under chain-tired traffic was found to be directly affected by the distance between bricks, wide joints causing marked increase in the rounding of the edges. From this it is concluded that the spacing between bricks should be the minimum consistent with proper penetration of the bituminous filter.

Importance of Bedding Course

As a result of the field survey it may be pointed out that the maintenance of a smooth-riding brick surface is largely dependent on a bedding course of uniform thickness and uniform compaction. The adverse effect of using too thick a bedding course or one of variable thickness is marked. The bedding course should not greatly exceed three-quarter inch in thickness and its uniformity depends on the degree of accuracy with which the base course is finished. Another construction detail which deserves attention is the application of the asphalt filler. There is a general tendency to use an excessive amount of filler and this results in a rough pavement surface. It is important that the filler used be adapted to the climatic conditions and that only enough be used to fill the joints. The advantages of smooth pavement surfaces in improving the riding qualities and in reducing destructive impact effects justifies careful control of these construction features.

This investigation has yielded results which indicate the possibility of very appreciable reductions in the cost of brick pavement construction. By the use of thinner brick very large aggregate savings may be effected and the value of the investigation as it may influence economy of construction is immediately apparent. For this reason the tests have had a particular interest since the benefits derived from them may be computed rather accurately in terms of money value. This is a characteristic not too common to research projects.

Demonstrated Value of Thin Brick

The accelerated test demonstrated the value of thin brick as a pavement surface but it did not demonstrate that the thin brick is necessarily the equivalent of the thicker brick commonly considered as standard in pavement construction. The use of thinner brick undoubtedly reduces the factor of safety and for this reason the maintenance of a uniformly high standard of quality is essential if advantage is to be taken of the indicated savings.

Several types of base have been observed to render satisfactory service under rather severe traffic conditions, but in this connection it should be emphasized that the first requisite of any brick pavement is a foundation which is stable, no matter what its type may be.

Conclusion

The above constitutes a brief review of a few of the more important recent developments in highway research. Many other projects, equally important, are now in progress or contemplated. The need for immediate information on many subjects has resulted in the simultaneous institution of many researches; so many, in fact, that to the casual observer, a present summary of investigations completed or in progress may seem a confusing list of apparently unrelated subjects. Each of these is a detail of intricate design and eventually will be fitted into its proper place. However, we have barely started on the program which has for its object the development of the new science of highway engineering. The work which has already been done, valuable as it is, is relatively insignificant when we consider the stupendous task which lies ahead.

World's Greatest Savers

On every hand there is evidence of our enormous spending power. Back in the decades of '80 and '90, a person having a good home, sufficient money to secure the necessities of life together with a moderate amount of cheap entertainment, was well satisfied. Today, the middle class home without its automobile, radio, and seats at the theatre or local games once or twice a week is the exception. We are spending more now-a-days because we earn more, and in so doing automatically increase the demand for all commodities.

Yet with all our spending, it must not be forgotten that we are also the world's greatest savers. Savings bank deposits in the country have increased 40 per cent per unit of population during the period from 1900 to 1920, and have been growing at the rate of 55 per cent per decade since then. Assets in building and loan associations rose to $41.11 per capita in 1925, which was 210 per cent over 1900. All of which comes from no less a source than the National Industrial Conference Board.

CONSTRUCTIVE BUSINESS METHODS APPLIED BY THIS SAND AND GRAVEL COMPANY

By E. D. Roberts

MASSILON is a thriving industrial city located in northern Ohio. A healthy industrial boom has been experienced since the world war, caused by the great demand for articles manufactured there. This industrial boom has caused considerable building activity which, coupled with the many miles of concrete roads which have been and are being laid down in the vicinity yearly, has created a steady demand for concrete aggregates. This tendency was noted soon after the war and caused the Clementz Company to open up a sand and gravel pit in 1919.

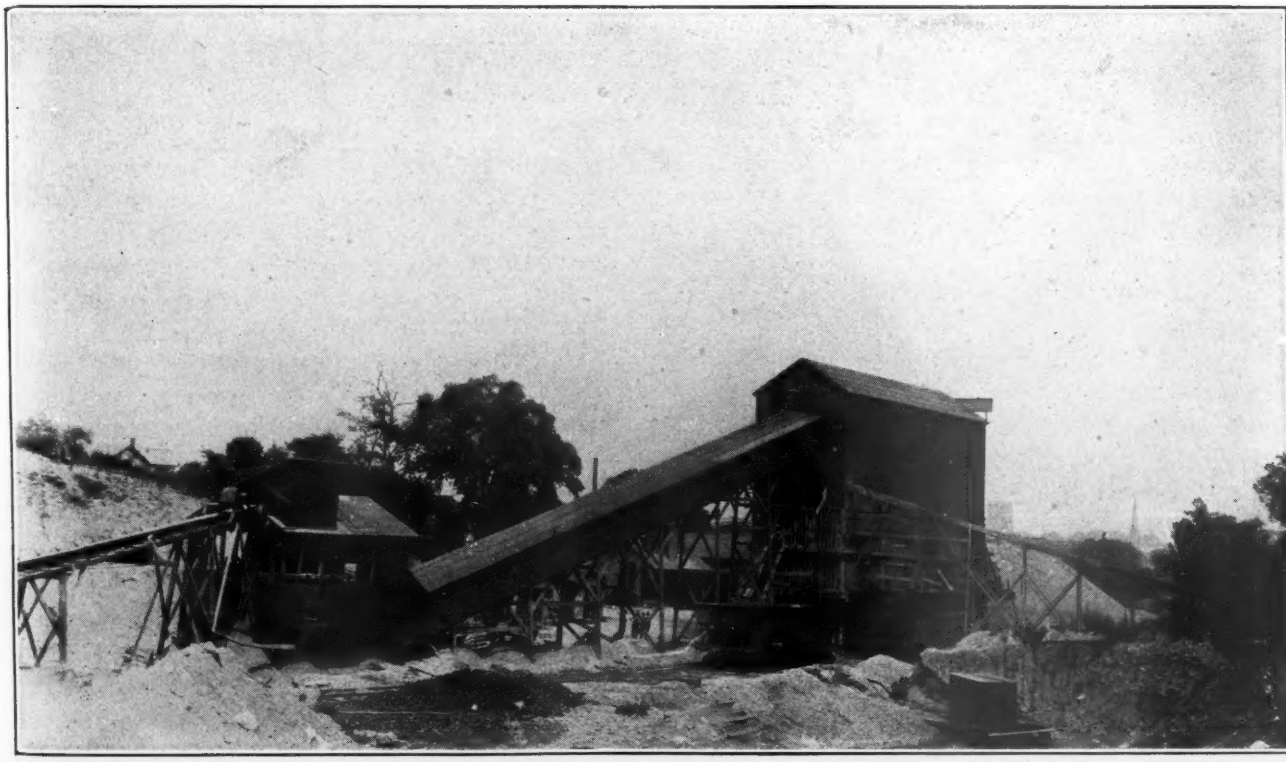
W. A. Clementz & Sons is a partnership handling a full line of building materials which are distributed throughout the Massilon industrial district by four well located distributing yards. W. A. Clementz originally founded the business and later took his two sons, William G. and Elmer E., into partnership, at the same time adding the "& Sons" to the firm name. At present, the name of the company is unchanged, out of respect for their father who has passed on, and the two sons are jointly managing and operating the business.

The selected site for this business comprises 29 acres, located within half a mile of the center of the city of Massilon, north of the main state highway, which runs through the city from east to west, and also west of the river which divides the city in the other direction. It is, therefore, ideally located to supply the demand by truck delivery for miscellaneous city business; while a spur from the Baltimore and Ohio Railroad, which passes the site, provides rail transportation for sand and gravel deliveries to nearby communities and other points of consumption.

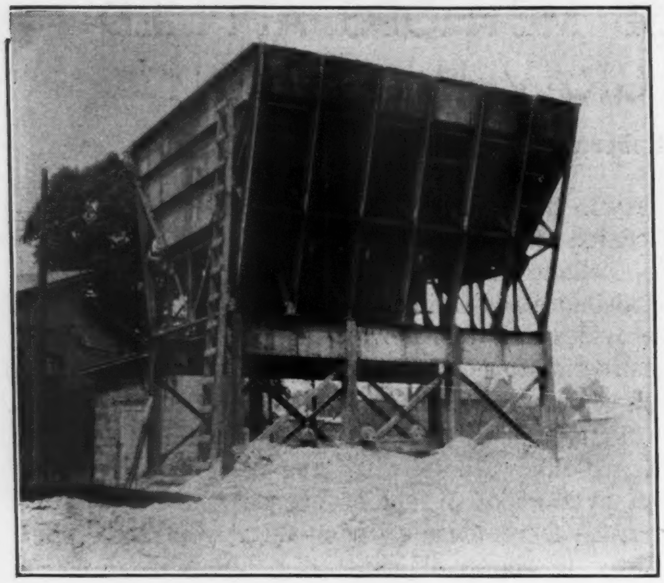
Fifty feet of excellent sand and gravel is found above the water level of the river drainage with an average of 5 feet of overburden. This overburden is removed by a steam shovel and carried away in dump trucks. Six hundred yards of washed sand and gravel are produced during one shift from this deposit with a total force of 9 men. During periods when the demand is low a reserve is built up in outside storage to carry over the peak summer demand and also to provide for winter requirements when extreme cold weather makes it impossible to wash the material.

The large percentage of sand produced from the deposit has made it advisable to install a block manufacturing plant. This plant has been producing 100,000 blocks a year which, together with the sand supplied to three competing block plants, has taken care of the plant's surplus supply of sand.

An additional scalping screen and a new Allis-Chalmers crusher were installed this year to lower the duty on the original initial crusher and scalper.



Screening and Crusting Plant at Left; Sizing and Bins at Right

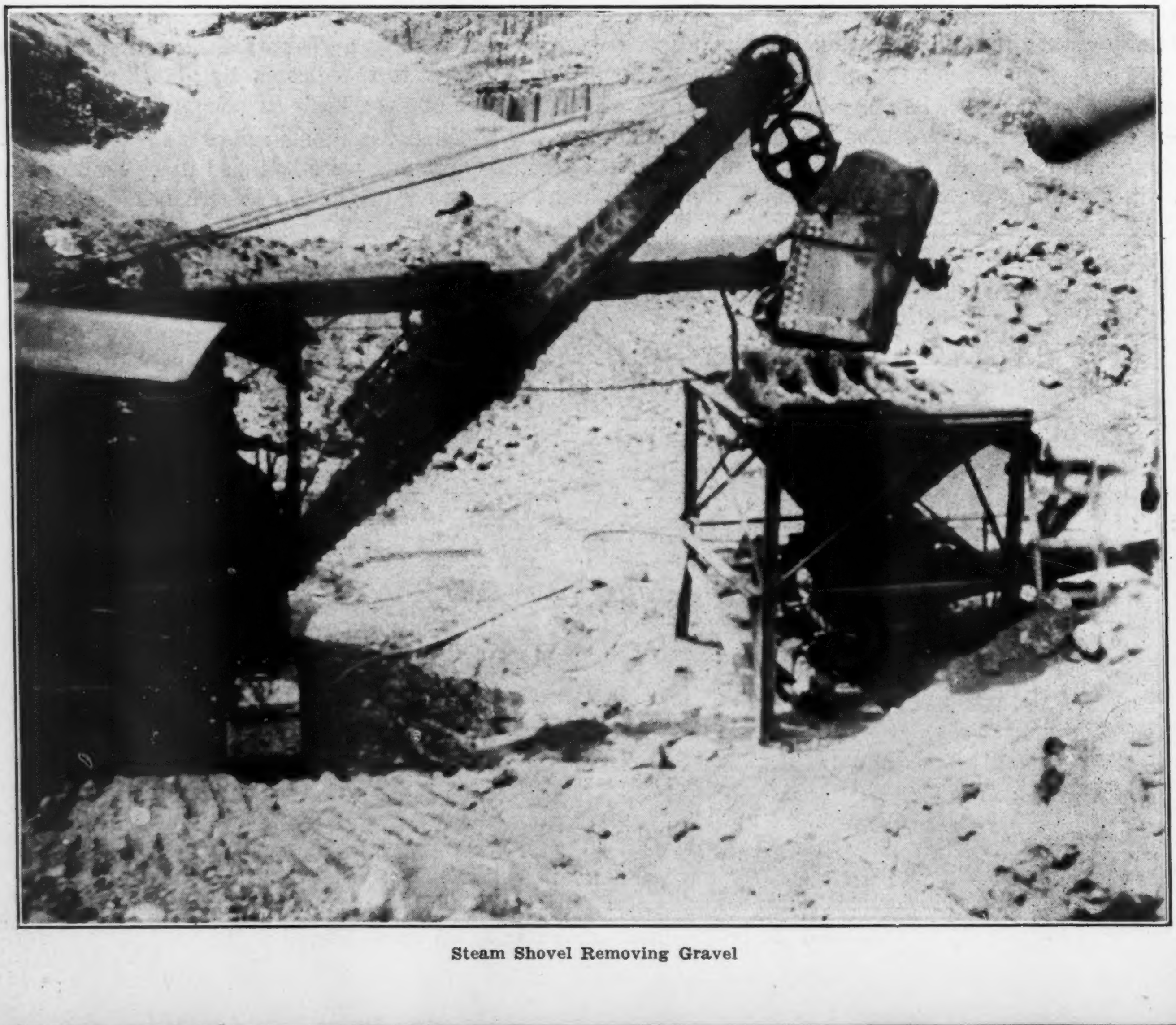


Batching Bins and Gravel Piles

This addition has allowed a greater yardage to pass through the crushing department which previously was found to be overworked when any attempt was made to increase production. Additional water has been provided for washing the material by sinking a new well and installing a new centrifugal pump. The plant water is provided by a Dayton pressure water system.

The sand and gravel is excavated from the bank by a Russel steam shovel, equipped with caterpillar traction and a 1-yard dipper. The dipper discharges onto a set of bars placed over the top of a steel hopper which prevent stray boulders from entering the hopper and thereby causing trouble, due to choking.

A home-made feeder, attached to the bottom of this steel hopper, controls the rate at which the sand and gravel falls onto a section of trussed field conveyor. This carries the material to a hopper located over the receiving end of the regular permanent conveyor which leads to the scalping screens. The portable or field conveyor is equipped with a 24-inch Goodrich belt and Bartlett & Sons rolls, similar to the permanent conveyor, but, due to its method of support at the discharge end, is free to rotate in the segment of a circle with the discharge end as a fulcrum. This arrangement allows the shovel to make a large circular cut without reconstruction of the conveyors, because when the shovel is ready to move ahead, it picks up the movable hopper and sets it down farther ahead, and, as the receiving end of the trussed conveyor

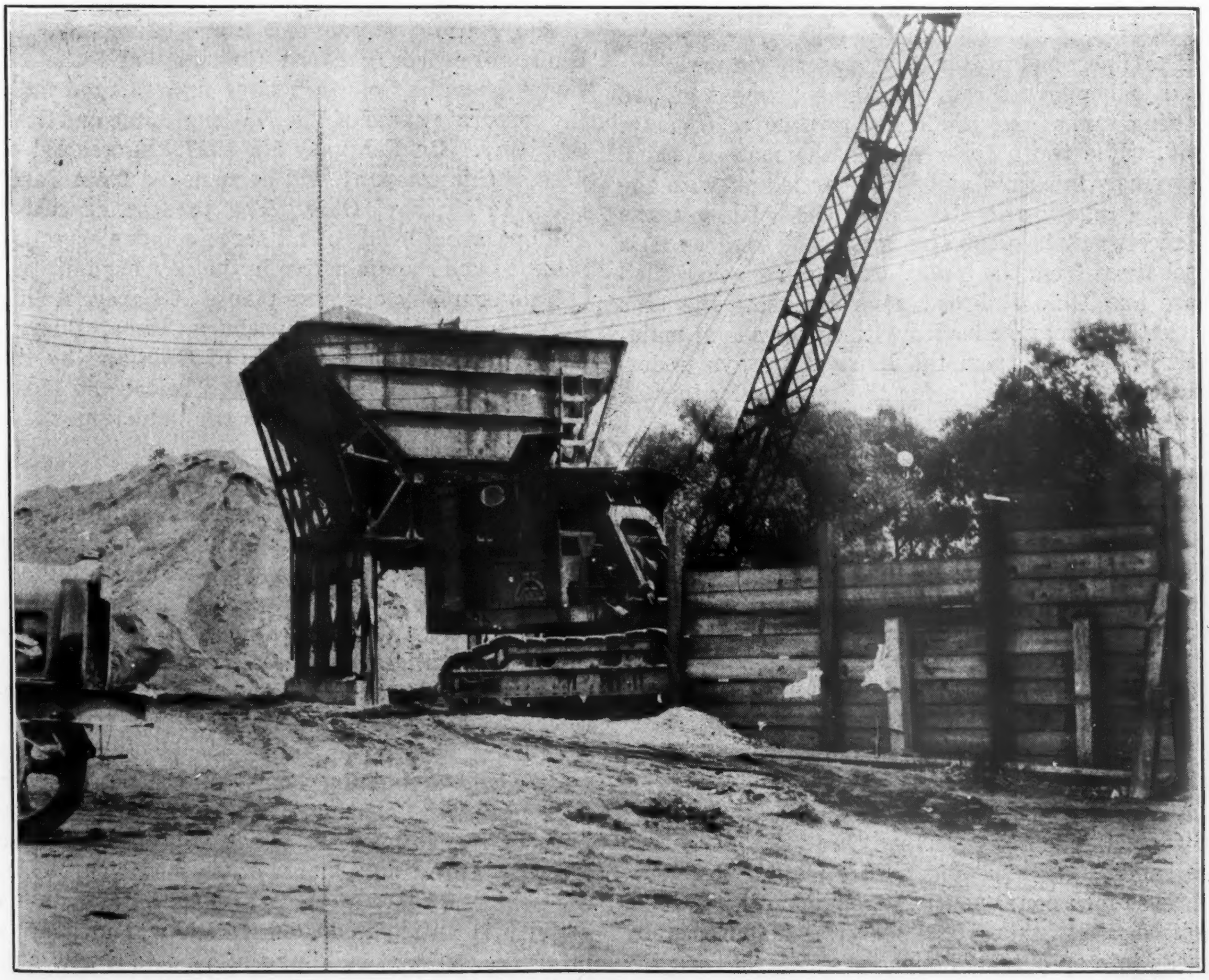


Steam Shovel Removing Gravel

is suspended below the movable hopper, this end of the conveyor also moves with it. Furthermore, as the shovel is equipped with caterpillar traction, there are no delays in the pit.

When the material arrives at the discharge end of the permanent conveyor belt, a revolving screen, 42 inches in diameter and 8 feet long, separates the material into two grades; that which passes through the one and three-quarter inch holes and the oversizes. A 24-inch inclined belt, leading to the washer, is so placed that the finer material reaches it by gravity and the oversize gravel falls directly into a Traylor crusher. The discharge from this crusher was formerly carried back to the scalper, previously mentioned, but, to increase the capacity of the plant, a second scalping screen was installed this summer to take the discharge from the Traylor crusher. This second scalping screen, which is 30 inches in diameter and 6 feet long, discharges everything over 1½-inch into a new Allis-Chalmers crusher, which was installed at the same time as the second screen. A short conveyor belt, located under the second scalping screen and the Allis-Chalmers crusher, receives their joint discharge and in turn, deposits the crushed material into a short bucket elevator. This elevator discharges onto the same inclined conveyor belt that receives the fines from the first scalping screen. Both crushers, screens, the short belt and the short bucket elevator are driven by a 30 horse power General Electric motor. A 20

View of Block Plant



Crane at Work Placing Gravel in Batcher

horse power motor operates the inclined belt conveyor from the scalpers, crushers to the washer and sizing screens, which are located in the top of the bin house.

The scrubber and sizer are combined, the first 6 feet being the scrubber, while the remainder of the barrel sizes the material. An eight-foot sand jacket with 3/8-inch round holes allows the sand and water to fall through into a flume leading to the settling tanks. Inside the sand jacket is another circle of steel plate perforated with 7/8-inch round holes, giving two grades of gravel, 3/8 to 3/4-inch and 7/8-inch to 1½-inch. Each of these two grades is chuted into the proper bin below or, by throwing in a deflector, either grade can be deviated into a chute leading to outside storage piles.

Water for washing the sand and gravel is obtained from wells, which have been sunk close to the washer plant. A 5-inch Weinman centrifugal pump previously furnished the plant with the washing water but this summer a 15 horse power 4-inch Weinman centrifugal pump was added. This larger pump is operated by a 15 horse power, Imperial motor. Three streams of water are fed into the scrubber, one, a 4-inch perforated pipe located on the axis of the scrubber, while the other two are 1¼-inch perforated lines placed close to the material.

The fines and water that passes through the sand jacket flow through a flume to a set of two settling tanks; one producing torpedo or concrete sand, while the other produces the masons' sand. Extremely fine sand and silt is carried off with the water. Bins are located below the settling tanks to receive their respective grades of sand as it is discharged from the tanks. A spur from the Baltimore and Ohio Railroad runs alongside the bins so that cars may be loaded with any grade of material, by gravity from the bins. Runways underneath the bins provide for the gravity loading of trucks for local shipments.

An Orton and Steinbrenner locomotive crane, with caterpillar traction, is used for storing the various grades of sand and gravel in outside storage piles and for reclaiming as desired. This crane is also used to place sand and gravel in a portable steel Blaw-Knox batcher when batched material is required. This batcher is equipped with three batching spouts at present with provisions for the attachment of three additional spouts. The company maintains a fleet of fifteen White dump trucks for delivery of sand, gravel, building blocks and other building materials.

A concrete block plant, also operated by the W. A. Clementz & Sons Company, is located near to the sand and gravel bins. This plant is operated by three men continuously throughout the year on a piece-work basis. The material is dumped by trucks into an outside hopper placed level with the ground. A bucket elevator raises the sand to the top of the building and discharges into a tank over a Kent mixer. From the mixer, the sand goes into a Post Economy press, and located alongside the Kent mixer is a Blystone mixer and an Ideal press, which are used for manufacturing the concrete blocks.

As the blocks are produced by the presses, they are placed on triple deck cars and wheeled into a room where they are steam cured. A transfer track across the intake end of three tracks in the curing rooms, allows access to any room from either press and another transfer track, across the exit end of the curing room, allows transfer of the car from any room to the several yard tracks.

Over 100,000 blocks are produced by this plant each year. At the beginning of the present season, there were 60,000 blocks on hand but when the writer was there only a few of these remained. In conclusion, it may be stated that the success of the Clementz Brothers is largely due to a desire on their part to deliver at all times a good product and, at the same time, to give adequate, cheerful service. The principal office of W. A. Clementz & Sons is maintained at 415 Canal Street, Massilon, Ohio.

Stone Companies Merge

The National Lime and Stone Company, the Bluffton-Lewisburg Stone Company and the National Quarries Company have now merged under the corporate name of The National Lime and Stone Company. On February 15, 1927, the general offices of this company will be removed from Carey, Ohio, to Findlay, Ohio. The present executives and operating heads of all three companies will be retained and remain active in the new organization.

This company operates plants at Carey, Arlington, Bluffton, Rimer, Lewisburg, Lima, Bucyrus and Findlay, all in the State of Ohio and by this consolidation it is expected that a better and broader service will be rendered to the industry.

(Continued from page 60)

to remain approximately the same, without any great element of change or disturbance. The program of building finance is operating smoothly and in readiness to take care of all sound projects—with an eye to discourage new building projects which show an economic weakness either from the viewpoint of demand or because of poor specifications.

In other words, the United States is apparently going about its building business in a sensible way, meeting requirements in a far seeing manner, and undertaking no program which will do other than meet the sane requirements of the situation. Over the next few years a gradual reduction of building activity is anticipated—one which will ultimately bring the national building program to a new normal of approximately $4,000,000,000 a year.

SELECTION, USE AND CARE OF EQUIPMENT

By W. H. Root*

THE discussion of these problems in this paper will be confined to state equipment. The same general principles apply to county or township machinery, but not all of the detailed recommendations are applicable in the smaller units of government.

The selection of maintenance equipment is a twofold problem. (1) The type of equipment must be determined, and (2) the particular make must be chosen. The general maintenance problem of every state is to maintain its state system satisfactorily at a minimum cost. This cardinal principle should always be kept in mind when equipment is being purchased or used. When in the development of your maintenance plans it is apparent that new machinery is needed, you should first make a careful study of the future development of the road upon which the equipment is to be used. Otherwise, you may have very satisfactory results for a year or two, and then find yourself with an expensive white elephant on your hands. You should also be sure that the type selected will fit in with the other equipment already on hand in that particular maintenance unit. In other words, cooperation of equipment as well as cooperation of men is essential.

Selection of Equipment

In choosing an equipment type, the most important consideration is that the equipment selected must do the job that you have for it, and that it must continue to do this job over a reasonable period of years. I mean by that that the type must be proven. A particular type machine has not established its right to serious consideration until it has been operated under typical conditions for a year or more. Do not construe from this that the purchase of new designs is undesirable. Every state should buy new developments of machinery adapted to their work, but such purchases should be limited to a few experimental outfits until the machine has proven itself. Personally, I do not look with favor upon so-called demonstrations. I never yet saw a machine fall down on a demonstration. A clever operator and a wisely selected road will put over any machine for a few days or weeks.

When you have determined the type of machine best adapted to your work, your problem is only half solved. Whose machine are you going to buy? Don't let the salesman do all of the talking. Ask a few questions yourself. Don't allow yourself to be sold by a salesman, but rather be sure you are sold on the machine. It isn't necessary that you buy the lowest priced machine, but you should be sure that the machine you buy is not overpriced. Some machines are priced for trade-ins. This fact is not hard to determine, and if you find it to be the case, don't pay cash at trade-in prices. You should also look into the matter of parts, prices and service. Any machine will require new parts occasionally, and these should be furnished at a reasonable price, and they must be furnished promptly. Delays due to poor service on repair parts are expensive.

Power an Important Factor

Also look to the power of any equipment you are considering. Horse power ratings are not always reliable and an underpowered machine is a constant expense and irritation. The fuel cost is another item which should be investigated. It is not enough that the machine do the work required of it, but it should do this work at an economical operating cost.

Then last but not least, in determining the dealer from whom you will make your purchase, keep in mind that it is always desirable to deal with a well established firm. Our junk yards are full of useless orphaned machines. The amount of money represented by this junk is a tremendous sum, and in my mind is one of the few public road expenditures which is open to criticism. In this day of rapidly changing conditions and methods, it is a problem for any machine company to keep its equipment abreast of the times. Machines are continually developing weaknesses, and proving unequal to the constantly increasing tasks to which they are put. These so-called "bugs" require study and adjustment. If when a machine is sold, the seller considers the deal closed, that machine is an undesirable purchase. Be sure the company you deal with is one that takes an interest in its sales, not only until your name is signed on the dotted line, but continuously thereafter through the entire life of the machine.

Care of Equipment

For the purpose of this paper it is not necessary to enter into any extensive discussion of the use of maintenance equipment. This subject in itself might readily be expanded to cover the whole field of road maintenance. In this connection, I simply wish to say that maintenance equipment should be used often, and should be used hard. However, it should not be abused. Use a machine for what it is designed plus a reasonable overload. This word "designed" is used advisedly. Some machines are designed to do certain work, while others are manufactured to sell. If you are a good buyer you will not have on hand any machines of the latter class.

*Presented Before the American Road Builders' Association, January 13, 1927.

All maintenance equipment should be properly cared for. If you will recall how you mothered your first Ford for a month or two after its purchase you will have an idea of how you should treat your road machinery, but this careful attention should not be allowed to lapse as soon as the paint wears off. Road maintenance equipment should be kept painted. This not only preserves the equipment against the weather, but it has a good psychological effect on the operator and upon the public. An operator is less apt to abuse a well painted machine than he is a rusty, weather-beaten one. Also the public will judge you somewhat by the appearance of your equipment. If you keep your machinery painted bright and clean the public will feel that you are endeavoring to conserve the road funds that they have supplied to you. On the other hand, if your equipment appears run down and uncared for, the public may get the impression that, if you are careless in these little matters, that you may also be careless in the larger matters of highway finance.

Inspection and Housing

All maintenance machinery should be gone over every few days and loose nuts, joints and bearings made tight. Rainy days when the equipment cannot be operated are ideal times for this kind of work. As to the housing of equipment, most machines should be stored inside in order to protect them from the elements and from the light fingered public. Road economists have figured that the depreciation (due to weather) on certain types of equipment is less than the interest and depreciation for housing facilities, and they, therefore, maintain that such equipment should simply be kept painted and stored in the open. Be that as it may, there is still the matter of public psychology to deal with, and for my part, I would prefer to house the equipment rather than be censured for an apparent neglect.

Lubrication

Without doubt, the most important consideration in the care of maintenance equipment is lubrication. I do not know of any modern road equipment that does not require some sort of lubrication, and on some of the more complicated types an hour of greasing and oiling each morning is a necessity. If we had perfect lubrication we would have no wear, and, barring breakage, theoretically our machines would last forever. The nearer we come to this ideal, the longer our equipment will last, and the more reasonable will be our maintenance costs.

In conclusion then, I would sum up the paramount points to be considered in selection, use and care of maintenance equipment as follows:

(1) Buy a proven machine from a reliable established dealer.

(2) Use it but do not abuse it.

(3) Keep it lubricated.

Two Cement Plants Finish Year Without a Single Accident

Three-hundred and fifty men at the Mitchell, Ind., plant of the Lehigh Portland Cement Company and 200 at the Winnipeg plant of the Canada Portland Cement Company, Ltd., went through the year 1926 without a single time-lost accident, according to W. M. Kinney, General Manager of the Portland Cement Association.

By making this record, each plant will be awarded a concrete trophy which carries the thought "Safety Follows Wisdom," and which is cast from a design created at the Art Institute of Chicago. These trophies will be presented to representatives of each plant at the Spring Meeting of the Association. The representatives will be chosen by the workmen. After the formal presentation, the trophies will be erected in the yards of the winning plants.

An annual contest for this award which is sponsored by the Portland Cement Association is open to all plants operated by member companies. In 1926, 129 plants in the United States, Canada and South America were entered in it. The plant which has the best safety record of the year wins the award. As two plants had perfect records during 1926, each will receive a trophy.

Although complete figures are not yet available, preliminary data indicate that fewer accidents occurred in cement mills in 1926 than in 1925, which was the banner year, up to that time. "In October of 1925, 253 time-lost accidents and nine fatalities were registered among the 40,000 workmen in cement mills," said Mr. Kinney. "In the same month of 1926, there were three fatalities and 143 time-lost accidents. This is a remarkable record, since October is the 'Jonah' month of the industry.

"The safety-first work of the Portland Cement Association since 1920 has reduced the number of cement mill accidents 50 per cent, although industrial accidents have increased in general during this period. When we first began this work 13 years ago, we found that responsibility for accidents lay about 25 per cent with the manufacturers and 75 per cent with the men.

"Investigators found that some of the machinery was dangerous, and that the men were frequently reckless. The manufacturers protected their machinery, and then we began an intensive campaign among the men. This work was begun for the benefit of their employes, but they soon found it to be a good dollars-and-cents investment, since it improved manufacturing personnel, reduced delays, and cut down accident compensation."

This is the second consecutive year in which two plants have been awarded trophies.

ULTIMATE HIGHWAY DEVELOPMENT

By Ben H. Petty*

WITH motor vehicle registration in this country increasing at the rate of approximately 13 per cent per year and the so-called saturation point still invisible, the question of either widening existing pavements or buildng parallel routes has become a major problem in thickly populated areas and will confront the highway officials of every state in the very near future. California now has approximately one motor vehicle to every three persons within its borders. Isn't it quite possible that within a few years the entire country may approach this degree of saturation? This would mean a total of some forty millions of vehicles, twice the present registration.

The problem covered by the subject of this paper is one that has developed largely during the past five years. In that period the registration of motor vehicles in this country has increased 100 per cent, or in round numbers from 10,500,000 to 21,000,000. Increased registration naturally means increased traffic. The following table, showing results of traffic counts at eighteen observation stations in Massachusetts during successive three-year periods from 1909 to 1924, illustrates the great increase in traffic during the past few years:

Year	Average Vehicles Per Day	Per Cent Increase Over 1909	Per Cent Increase Per 3 Yr. Period
1909	270	....	...
1912	430	59	59
1915	760	181	77
1918	1180	337	55
1921	1950	622	65
1924	3721	1279	91

Similar results are shown by annual traffic counts on the Maryland state highways from 1917 to 1924 as indicated in the following table:

Year	Per Cent of Yearly Traffic Increase
1918	7.4
1919	28.2
1920	23.7
1921	22.3
1922	7.8
1923	25.4
1924	12.7

Highways Badly Congested

As a result of this great increase in motor traffic, highways which only a few years ago were entirely adequate, are today so badly congested that in some cases they are actually handling less than full capacity of traffic. It is rather amusing now to recall some of the many criticisms hurled at those officials responsible for the ideal section of the Lincoln Highway constructed near Dyer, Indiana, about 20 miles south of Chicago, in 1922. The idea of a forty-foot paved roadway in a rural district was considered preposterous by some and prophesies were made that traffic would never demand such a width of pavement. But already we have gone far beyond this limit in some communities with widths of fifty, sixty and even seventy-two feet of pavement on suburban roads.

A subject of this kind is more or less of a controversial nature and definite facts and figures supporting either side of the question are somewhat scarce. It has been the writer's plan in developing this paper to present some of the more noteworthy examples of both pavement widening projects and developments of parallel routes and then follow with some of the more convincing arguments both for and against each of the two plans for relieving traffic congestion.

*Presented before the American Road Builders' Association at Chicago on Tuesday, January 11, 1927.

Examples of Widening

Some of the more notable examples of pavement widening in various parts of the United States are as follows:

1. That part of the Boston Post Road running north from New York City across the state of Connecticut to New Haven is one of the heaviest traveled roads in the East. In an effort to relieve the serious traffic congestion, the Connecticut highway officials have started a program of progressive widening on that part of the road extending from the New York state line to New Haven. The pavement is being widened to 36 feet providing 4 nine-foot traffic lanes.

2. The historic White Horse Pike extending 50 miles from Camden, New Jersey, to Atlantic City is being widened to accommodate the tremendous volume of motor traffic that pours into the famous seaside resort. The pavement is being widened by the addition of concrete shoulders. When the program is completed a paved width of 30 feet will be available throughout its entire length. More than half of this widening was completed during 1926.

The traffic on this road has been greatly increased since the opening of the Philadelphia-Camden suspension bridge over the Delaware River. The highway forming the Camden approach to this bridge is being widened to a paved width of 76 feet between curbs. W. S. Dean, State Highway Engineer of New Jersey, predicts that this section of paved highway will handle over twenty million vehicles per year. This practically equals the total registration of motor vehicles in the United States at the present time.

3. During the last two years, the Lincoln Highway west of Philadelphia has been widened from 20 feet to 40 feet by building 10 foot concrete slabs either side of the old 20 foot bituminous macadam pavement. This is termed a "dual type" pavement. Progressing further west from Philadelphia this total width is reduced to 30 feet and finally merges into the standard 18 foot pavement.

4. Michigan provides several examples of wide pavements. One of the most notable being the Detroit-Pontiac superhighway, known officially as Wider Woodward Avenue. This consists of a 204 foot right of way carrying two 44 foot concrete slabs separated by a 40 foot car track section, thereby providing a complete separation of traffic in opposite directions. Kent County has fixed 40 feet as a minimum pavement width for future construction.

5. The Portland-Kittery highway, which is estimated as carrying 75 per cent of the tourist traffic into Maine, is being widened to 27 feet by the construction of 9 foot concrete slabs each side of the present 9 foot bituminous pavement.

6. In 1925 the Cahuenga Pass Highway leading out of Los Angeles to the north was paved to a width of 36 feet. Within a few months this width proved inadequate to handle the rapidly increasing traffic and during 1926 it was widened to a total paved width of 72 feet. This is one of the widest suburban, continuous pavements to be found in this country.

7. The biggest single program of wider highways ever undertaken is now under way in Cook County, Illinois. The program will bring about the pavement widening to 40 feet of 125 miles of main highways and the building of 247 miles of new 20 foot pavements, in addition to widening shoulders, intersections and connecting city streets. A total of over 500 miles of streets and roads is affected at a cost of $32,000,000.

Du Page County, adjoining Cook County on the west, is planning three so-called super-highways extending east and west across the country. The plans call for 200 foot rights of way with two 40 foot pavements separated by a parkway and car track section 45 feet wide. All other state and county roads will have rights of way of 100 feet and 66 feet will be the minimum for roads of lesser importance.

Arguments Favoring Wide Pavements

The arguments advanced in favor of widening our standard, two-lane, paved highways may be summed up as follows:

1. Providing more than two lanes for traffic possible accidents due to attempts at passing around slow moving vehicles.

2. Three or more traffic lanes greatly increase the carrying capacity of a highway since the extra lanes permit fast traffic to pass around trucks and other slow moving vehicles, thereby raising the average speed of all vehicles using the road.

Arguments Against Widening

The following arguments may be advanced against the policy of widening our standard two-lane pavements.

1. It increases danger due to high speed on the adjacent inner lanes, the slow traffic being relegated to the outside.

2. Great expense is involved in securing the needed right of way for widening, after adjacent property values have been greatly boosted by the construction of the original pavement. Almost invariably the paving of a highway brings about an increase of property values alongside. On roads leading out of our cities this increase may be manyfold in a reasonably short period of time. Buildings immediately spring up along such roads extending farther and farther from the city resulting in almost urban conditions for several miles beyond the city limits.

3. Traffic congestion will be intensified at points where such widened highways pour their traffic into the cities or into other rural traffic arteries.

4. Adjacent property owners object to the multiplied noise and confusion incident to the greatly increased traffic carried by the widened pavement.

5. Construction difficulties due to necessary disruption of building lines and public utility installations as well as the expense and inconvenience incurred by the various companies involved in moving car tracks, pipe lines, pole lines, etc., argue against pavement widening in built up sections.

6. Widening pavements to form 6 and even 8 traffic lanes introduces multiplied difficulties at highway and street crossings. Cross traffic must be justly cared for. If uniform interval, stop-and-go signals are installed, the heavier traffic on the wide road is frequently delayed and the capacity of the road is greatly decreased. On the other hand, if non-uniform time signals are installed it may work an injustice on the cross traffic.

The Pedestrian Problem

In cities a serious problem is presented in getting pedestrians safely across the very wide streets. Some have suggested "islands of safety," spaced at regular intervals, across the street to aid pedestrians in a safe crossing. These islands bottle-neck the boulevard and greatly reduce its efficiency. The apparent solution to this crossing problem involves the construction of either underpasses or overhead crossings so as to permit the traffic to use the widened pavement to its fullest capacity. Of course, this would evolve enormous expense and would be quite impractical on highways having cross roads at frequent intervals.

Examples of Parallel Roads

To the writer's knowledge, there are very few examples of parallel highways constructed with the idea that they were to serve as parallel routes. It is true that there are some localities in which highways constructed some years ago are, as a result of enormous traffic increases, now functioning as parallel highways as we understand the meaning of the term. This is illustrated by the highways leading out to the west from Philadelphia. In addition to the Lincoln Highway there are three other state highways of major importance, lying to the south, which handle great volumes of traffic.

Similar conditions exist in the vicinity of Chicago. The new road program for Cook County provides for the construction of about 250 miles of new pavement that will, in reality, serve as a network of parallel routes for dispersing traffic. When completed there will be at least ten paved roads radiating out of Chicago to the northwest. These possibly could be classed as parallel roads insofar as the dispersion of outgoing traffic is concerned.

In Westchester County, New York, a parallel route to the Boston Post Road is being constructed and surveys are being made for a parallel route to the Albany Post Road. In addition the county is spending considerable sums in the building of fast traffic routes or parkways on which business traffic is excluded and the light or pleasure traffic is allowed to travel at the rate of 35 miles per hour. Grade crossing are eliminated so that there is very little interruption in the flow of traffic. These parallel routes are being constructed 36 and 40 feet wide.

In the vicinity of Cleveland and other centers of unusually heavy traffic in Ohio a program of parallel highways is being carried out. In some cases this results in a boulevard system consisting of two 18 to 30 foot pavements with a parkway between.

Arguments for Paralle Roads

Those who favor parallel routes reason as follows:

1. Better dispersion of traffic is obtained which reduces congestion and probability of accidents.
2. The construction of parallel routes boosts real estate values along the new location, thereby increasing prosperity of the owners and providing greater resulting revenue from taxation.
3. As a rule, the right of way needed for a parallel route can be secured much more cheaply than the necessary right of way for widening an existing, over-loaded highway the original construction of which greatly increased property values alongside.
4. Paved road benefits and service are extended to more taxpaying units.
5. Makes possible the segregation of traffic by assigning truck and slow moving vehicles to one route and high speed traffic to the alternate route. By this plan the pavement carrying heavy truck traffic can be designated of adequate thickness to safely withstand the action of the traffic, while the parallel road carrying the lighter traffic, can be built thinner. Obviously this makes possible a considerable saving of taxpayers' money.

Arguments Against Parallel Routes

The following objections are pertinent to parallel routes:

1. Unless 3 traffic lanes are provided on each route, both will become inefficient due to slow moving vehicles setting the pace for all traffic in each lane.

A few years ago, at the time of a foot ball game at New Haven, the Boston Post Road became so congested by a mixture of slow and fast vehicles that the average traffic velocity was from 10 to 18 miles per hour. In order to speed up traffic, one of the division engineers with his assistants removed all trucks and "mopes" from the two-lane pavement and as a result the average traffic speed increased to 30 to 40 miles per hour. This indicates quite convincingly the value of segregating traffic where two-lane pavements are concerned.

2. It is doubtful if two parallel, two-way traffic roads with 20 foot pavements will carry as much traffic as one 40 foot pavement. On the latter, slow speed traffic can be forced to the outer lanes, leaving the center for high speed. In cases of unequal volumes of traffic in opposite directions the four-lane road can still be used to capacity while the two-lane road is inefficient due to danger in passing around slow traffic.
3. In general, the number of drainage structures will be multiplied, thereby increasing the cost as compared with the extension of existing structures when pavements are widened.
4. The number of railroad grade crossings would be increased in many cases.

A Wisconsin Parallel Road

A rather interesting situation has arisen in connection with a parallel road development in Wisconsin. State Road No. 19 paved to a width of 18 feet from Milwaukee to Madison is one of the most important roads in the state. A peak traffic count on this road recorded 17,000 vehicles in 24 hours. It is estimated to carry an average daily traffic of 6,000 vehicles throughout the entire year.

About five years ago the state highway officials of Wisconsin conceived the idea of building a parallel road one and one-fourth miles south of Road 19 to relieve the serious congestion. This parallel road was so located as to lead directly from Waukesha, a city of 15,000 population, to Milwaukee, entering the latter on National Avenue, which is one of the principal streets on the south side. The high daily traffic count taken on Road 19 the year previous to the building of the parallel road was 11,500 vehicles. The first year the new road was opened it carried a maximum daily traffic of 5,500 as compared to 13,600 on No. 19. Traffic has increased more rapidly on the old road than on the new, culminating in a maximum of 17,000 vehicles in 1926, as compared to 8,500 on the new road.

This illustrates the fact that some roads, due to certain strategic advantages in location, must continue to carry traffic that will not be diverted to parallel routes. In such cases widening is not only justified but absolutely necessary. Wisconsin plans to construct a 40 foot pavement a few feet to one side of the present 18 foot slab on No. 19 and install one-way traffic regulations. Eventually this highway will consist of two 40 foot pavements separated by a 30 or 40 foot parkway.

Discussion

Our great handicap now, where widening is desirable, is the lack of sufficient rights of way. Great sums of money could be saved to the taxpayer if those who planned our present street and road systems had only possessed the foresight to vision the present traffic and have provided sufficient rights of way to permit widening of pavements as necessary. It is rather presumptuous for us to blame our predecessors for this condition unless we clear ourselves of future censure by securing, at once, on our present roads, adequate rights of way to care for traffic increases for several years to come.

It has been proposed that highway officials adopt the policy of securing at once sufficient rights of way to care for the maximum practical future width of the pavement. This would prevent the erection of buildings so close to the road that they would have to be moved later when pavement widening becomes a necessity. The excess land not used for present traffic could be leased back to the farmers for cultivation until needed for roadway purposes.

Providing Park Space

In constructing wide pavements of four or more traffic lanes, it is desirable from the standpoint of safety to provide a park space at the center to entirely separate traffic moving in opposite directions. On wide pavements, slow traffic will naturally be crowded to the outer lanes, thus throwing the high speed traffic in close proximity at the central lanes. Considering the many careless, incompetent drivers on the roads today in addition to the dangerous "hip flask" drivers, it is quite evident that the park space separator is justifiable.

There is one handicap due to this park space that should be pointed out. Traffic flow in opposite directions is seldom equal. For example, the traffic is usually greater toward cities in the morning and away from cities in the evening. The park space in a case of this kind would cause one-half of the pavement to be overcrowded, while the other half might be quite free of traffic. Where no park space is present, the denser traffic can spread out onto the unused lane or lanes of the other half of the pavement. While this may increase traffic hazards, it nevertheless utilizes the full width of the pavement.

Between Seattle and Tacoma plans have been prepared for a wide highway consisting of two 20 foot slags of concrete separated by a 4 foot gravel strip. This will tend to separate opposing traffic, but by providing a graveled crossover it will still permit full utilization of the entire pavement during periods of unequal traffic flow.

Carrying Capacity of Pavements

Due to the many variables involved and assumptions to be made, it is rather difficult to compute the theoretical maximum hourly vehicle capacity of highways. The total number of vehicles passing a given point in a unit of time in a single line is dependent on the velocity, spacing distance between vehicles and length of vehicles. A. N. Johnston, Dean of Engineering at Maryland University, has proposed the following formulas for use in determining the maximum traffic capacity of a road based on a single line of traffic:

(1) $N = \frac{5280\ V}{15 + C}$, N being the number of vehicles passing a given point per hour, V the velocity in miles per hour, and C the clearance between vehicles in feet.

Naturally the spacing between vehicles increases as the velocity increases, as a matter of safety. From observations on the Washington-Baltimore Road during special rush hours it was found that vehicles moving 10 to 15 miles per hour were frequently spaced as close as 15 feet and groups moving 25 to 30 miles per hour averaged 50 to 60 feet between vehicles. This and other evidence seemed to indicate that the spacing between vehicles varies approximately as the square of the velocity. If this is correct, then

$C = \frac{V}{15}$ and

(2) $$N = \frac{5280\ V}{15 + \frac{V}{15}}$$

To determine the maximum value of N, the first differential of this equation is equated to zero giving V a value of 15. This indicates that the maximum vehicle discharge will occur when the line of vehicles is moving at 15 miles per hour. (Studies by Col. Nathan W. MacChesney of Chicago show maximum actual traffic output at a speed of about 22 miles per hour.) For a single line of traffic averaging 15 miles per hour Dean Johnston's formula gives 2,640 vehicles per hour or a total of 5,280 for a two-lane pavement.

Observations of actual traffic, however, do not seem to indicate such high results as obtained for theoretical maximums. Observers stationed on this section of the Washington-Baltimore road reported uncomfortable crowding when single lane traffic reached about 1,200 per hour.

Pennsylvania Observations

Observations made by the Pennsylvania Highway Department on a pavement along the west bank of the Susquehanna River across from Harrisburg also indicates that actual maximum traffic falls considerably under figures obtained by the formulas that have been developed. This particular highway was a two-lane pavement with a car line alongside. At peak periods the traffic survey indicated that approximately 1,500 vehicles were carried. Based on these observations, a maximum of about 1,700 vehicles per hour was deemed possible.

Mr. R. F. Kelker, Jr., of Chicago has proposed the following formulas for determining road traffic capacities:

(1) $$C = \frac{3600}{T + \frac{L}{S}} = \frac{3600}{T + \frac{12}{M}}$$

As $T + \frac{12}{M}$ = time in seconds between center of cars, then

(2) $$D = \left(T + \frac{12}{M}\right) \times \left(\frac{88M}{60}\right) = 1.467\,MT + L$$

C = Number of cars per hour per lane.
T = Time in seconds between cars.
D = Distance in feet between car centers.
S = Speed in feet per second.
M = Speed in miles per hour.
L = maximum car length = 17.6 feet.

He does not agree that the spacing between vehicles varies approximately as the square of the velocity.

Based on his observations at points of heavy traffic in Chicago, Mr. Kelker differentiates between the theoretical maximum vehicle capacity and the practical or "use" capacity in the following conclusions:

A. For theoretical maximum capacity:
   1. The output of an unobstructed single lane is upwards of 3,300 cars per hour.
   2. The speed of cars for this output is upwards of 25 miles per hour.
   3. The variation in output between 20 and 35 miles per hour is inconsequential.

B. For practical or "use" capacity:
   1. The output per lane per hour where, at points of heavy cross traffic a good system of control is installed, is upwards of 1,500 cars.

Conclusions

The majority of highway engineers and officials consulted by the writer considers 40 feet as being the maximum desirable continuous width of pavement for our heavily traveled highways. Where this is not adequate for the traffic, parallel routes (not necessarily within a mile or two of the road involved) should be developed to handle the excess.

The following quotations are from the report of the "Committee on Highway Traffic Analysis" of the Highway Research Board rendered in December, 1925: "Investigations indicate that the 20-foot roadway is of ample width to provide adequate clearances between the sides of vehicles and the edges of the roadway, and between passing vehicles."

The Committee concludes that twenty-two and twenty-four foot roadways are not required for two lanes of traffic" . . .

. . . "The illustrative data submitted indicates that roadways of from twenty-four to thirty feet in width are used as three-lane, two-way roadways. Unfortunately, however, traffic movements on the middle lane cannot be governed by a right-of-way regulation. Hence the use of three-lane roadways provides conditions under which accidents may frequently occur. The Committee, therefore, from the standpoint of encouraging design which will promote the safe utilization of highways, recommends the use of the four-lane roadway when the highway transport survey indicates that the traffic capacity of a two-lane, two-way roadway will be exceeded."

Bottle Neck Elimination

Widening should not be considered until all bottle necks and other obstructions have been eliminated and adjacent roads are receiving their fair share of traffic. A two-lane pavement should reach a peak load of approximately 2,000 vehicles per hour of unsegregated traffic before being widened. Justification of wide pavements should not be considered on the basis of constant efficiency. There are bound to be slack periods of traffic on our superhighways which is also true of our standard two-lane roads. Peak traffic should be the governing factor.

(Continued on page 106)

THE HIGHWAY SITUATION IN MEXICO

By Andres Oritz, C. E.*

MEXICO, as far as highways are concerned, is still in its infancy. It was not until 1925 that the Mexican Government with great enthusiasm started a definite program to give the country a system of modern highways. Work has been begun on a solid basis, filling a great national necessity, and I am glad to say that it has taken place with the whole-hearted support and approval of the people of Mexico. In view of this we expect road building in Mexico will increase in the proportion of the rolling snow ball and that within a few years our immense and wonderful resources, unique in the world because of its great variety of raw materials necessary for modern industry, will be fully exploited in order to better the economic and social condition of our people.

The program of the work has been based on the taxation of gasoline and tobacco, which at present amount to about one million pesos per month. Congress recently passed the National Highway Law, which authorizes the Federal Government to issue bonds for the construction of highways, when it is deemed convenient to do so. In my opinion, I feel that our highway work should be based fundamentally on the funds available from these taxes, and increase the work progressively as the revenue of said taxes increases with the experience and training we are now acquiring.

Spent 13,500,000 Pesos

During 1925, the first year of extensive road building in Mexico, the Government spent thirteen and one-half million pesos, which corresponds to about 4.4 per cent of the total Federal Budget, while the American Federal Government spent during 1925, only 3 per cent of the total Federal Budget. I base my opinion on these figures when I say that our Federal Government has started to build an elaborate network of highways in Mexico.

Unfortunately, the same cannot be said about the States and Municipalities of the Republic, which in the United States help support the cost of highway construction. However, we hope that they will soon follow the example of our Federal Government. The Federal Highway Commission of Mexico, created to promote the construction of national roads in the country, bought machinery for approximately three million pesos, being equipped now with machines of various types and sizes which will efficiently build and maintain our roads. All the machinery that is at present used in Mexico is of American make and bought after careful selection of the best manufacturers. I desire to call your attention to the fact that the American engineers who worked with us were greatly surprised about the ability and quick adaptation of our laborers and mechanics, who after 30 days could run any type of tractor, grader, steam shovels, distributors, drillers, with praiseworthy efficiency. In several parts of the country, before the Federal program was started, some few roads were built on a basis similar to your old "Toll Roads." However, experience tells us that this method of operating roads will not do in Mexico.

Mine Owners to Build Roads

Some mining companies have asked permission to build a few roads at their own expense and to open them to traffic with no other compensation than that they may have a means of transportation for their products. All they have asked for is traffic regulations that will allow proper maintenance. In regard to this we have begun a system of construction and operation that I believe will greatly help road construction in our country. A firm, or a group of firms, operating in a certain isolated region proposed to furnish sufficient capital for the building of a road. These companies pay annually before the construction of the road an amount of pesos for taxes. When the construction is finished they are in position to increase their bulk of operations, which will, of course, increase the taxes to, let us say, A plus B pesos. The difference, B, during a certain number of years, in accordance with the contract, is then used for the payment of the capital invested in the building of the road and interest on same. This method is very feasible in Mexico, where many good roads are absolutely necessary in order to export rich minerals as well as many agricultural products yet unexploited.

Work on Cost Plus Basis

During the first year of highway construction we worked on the cost plus basis. We know that this method is neither the more economical nor the more convenient, but its adoption was justified then, since it was urgent that work be started as soon as possible, due to the great number of laborers unemployed who would not stand for the further delay occasioned by arrangement of plans, estimates, specifications, etc. Now while constructing the Puebla and Pachuca roads, of which I will speak later, and a few stretches of the Toluca, Acapulco and Monterey roads, the final location of these two last roads was completed, as well as the specifications for roads and bridges made especial-

*Presented before the American Road Builders' Association at Chicago on Wednesday, January 12, 1927.

ly to adapt themselves to our materials, climate and traffic. The Federal Highway Commission is now in a position to continue the work under better circumstances and no doubt will adopt construction under unit prices.

Traffic Increases

The increase of traffic on the roads recently built has been surprising. Such roads as the Puebla that before reconstruction had only a traffic of 10 vehicles per day, have now reached 1,000 vehicles daily, counting automobiles, trucks and busses; besides this there is a constant tendency for traffic increase. A traffic count has been established in order to determine the type of wearing surface required for our roads. In order to avoid confusion in traffic produced by local regulations, the Government has ordered a Federal Traffic Regulation to be inforced throughout the whole Republic by the Federal Highway Police and local authorities.

In Mexico, especially in the Great Central Valley—Mesa Central—bounded to the east and west by mountains, there is a great variety of construction materials of very good quality that can be used in road building. The group of volcanoes in our territory, such as the Ceboruco on the west coast; Popocatepetl, Ixtlazihuatl, Sleeping Lady, Ajusco, Nevado de Toluca on the Central Valley; La Malinche, El Cofre de Perote, and El Pico de Orizaba on the east coast, contain many deposits of volcanic rock and ashes that have been used to good advantage and economy in our work.

Composition of Sub-Grade

Our soil is formed principally of tufas of sedimentary formation, formed by accumulation of fragments of volcanic rock washed out. Some of these tufas are known as "tepetate" and correspond to the type of porfidic tufas and pomosa tufas, having as principal elements sands, aluminae, carbonates, feldespates and water; some "tepetates" have as high as 70 per cent of sand. From this it can be seen that "tepetate" is a mixture somewhat resembling sand clay formed by nature and which makes a splendid wearing surface for roads. Our "tepetate" roads have been surface treated with asphaltic oils with best results and have resisted traffic of 1,000 vehicles per eight hours.

The wearing value of the "tepetate" varies with its composition, but in general allows grading, once scarified, with such heavy machines as the Rip-Snorter, or else using first a heavy scarifier and then the grader. On the Pachuca road we used for grading units a "Best" 10 ton H. P. tractor and an Austin Rip-Snorter road machine. In a great many instances it was sufficient to drag the road in order to consolidate it, or compact, and only on a few stretches rollers were used.

Secondary Roads

"Tepetate" roads, protected with asphaltic oil treatment and well drained, will undoubtedly be the solution for a second class road for the great central valley of Mexico. We have also heavy asphaltic oils available that contain from 65 per cent to 70 per cent bitumin soluble and carbon bisulphide, which have given splendid results especially for the construction of penetration macadam. The construction program for 1927 of the Federal Highway Commission, presided over by Mr. Antonio Madrazo, is to first finish the Mexico-Acapulco and the Mexico-Laredo roads; this last one will be a connection of the American Highway System, forming the Mexican link of the Great Meridian Highway at Laredo, Texas.

The construction program during 1926 was carried out as follows:

The Mexico-Pachuca road, which is the first 93 kilometers link of the Mexico-Laredo road where work was started early in 1926, was opened to traffic on the 5th of September. The first 27 kilometers were built on flat country, having a cross section of 10 meters; 6 meters for the surface and two meters for each shoulder. The surface is of waterbound macadam treated with Catchinite asphaltic surface. From K.27 to K.93, the typical section is 10 meters wide, surfaced with "tepetate." The maximum gradient is 4 per cent and only in a very few places. The rest of the road is on flat ground.

Roads May Open Resources

Pachuca, the capital of the State of Hidalgo, is a mining center of great universal importance. It has been producing silver since the time of the Spanish domination and merely to give you an idea of the importance of this mining center I will quote silver and gold production during 1925: Total tons mined 1,984,404, of which 4,402 Kgs. of gold and 828,130 Kgs. of silver were extracted. This production corresponds to the mines of El Chico, Pachuca, Real del Monte and La Reforma that have now been connected by a modern highway with the capital of the Republic. From K.27 at Venta de Carpio, a branch road has been built to the famous Pyramids of San Juan-Teotihuacan. This stretch was also located on a flat country which allows gradients less than 4 per cent and curves with minimum radius of 40 meters. The cross-section is 10 meters wide including shoulders. The wearing surface has been built of "tepetate" mixed with volcanic cinders or ashes which has proved to be an excellent combination. On this also asphaltic treatment will be applied.

Famous Scenic Regions

The importance of San Juan Teotihuacan is mainly due to the archeological zone of Teotihuacan, located at the northeast of the town of the same name. The Pyramids of the Sun and of the Moon and the Citadel from a group of prehistorical monuments of great interest to the tourist and scientific people. Their surrounding mystery, their correct form of construction and alignment is an eloquent demonstration of the advancement and civilization of the people that built them, whether with sacred purposes or merely to have advanced strategical points for protection. The fact that the Pyramids are truncated shows that at least they used them as temples to worship their gods.

It would be a long task to try to describe the diversity and beauty of the archeological zone of Teotihuacan. Many good books have been written on this subject and thousands of tourists visit them! As I said before, the Mexico-Pachuca road is the first link to the Mexico-Laredo road, which, after being built, will be the gate for American tourists to come, see and admire our beautiful antique monuments.

Mexico-Puebla Road

The Mexico-Puebla road connects two of the most principal cities of the country; it has a length of 135 kilometers versus 210 kilometers of the shortest railroad line between these two cities. On the way out of Mexico City the road has a boulevard section of 8 meters paved surface, and 4 meters of shoulder. The 35 first kilometers are located on level ground, with very ample curves, going through many small towns of the State of Mexico and through a very rich agricultural region. From K.35, Zoquiapam, to K.91, San Martin Texmelucan, the road was located through very steep mountains, having a cross-section of 5½ meters paved surface and 1 meter of shoulder. The average maximum gradient is 6 per cent, but there is a little stretch where it is 7.8 per cent.

From K.97 to K.135 the road again was located through a very light rolling country and flat ground, going through towns of importance such as Huejotzingo and Cholula, of great historical importance. The first 57 kilometers have been built of macadam treated with asphaltic oils and the rest of the road has a wearing surface of local materials, such as "tepetate" and sand-clay, which are now being treated with the asphaltic treatment known as "Catchinite," using preferably Catchinite processes No. 1 and No. 2.

Volcanic Regions

The Mexico-Puebla road, of great commercial importance for the region it crosses, has also many charms for tourists of both towns. The mountainous section of this road, located at the slopes of the Ixtlazihuatl volcano—Sleeping Lady—has the most beautiful and varied panoramas of the Mexico and Puebla valleys, as well as in the mountain region itself, with the Ixtlazihuatl and Popocatepetl volcanos as principal attractions. Among the principal towns this road connects, besides the capital of the Republic and the city of Puebla, is the town of Cholula, one of the most interesting towns on the American continent from the historical and archeological point of view.

Bernal Diaz, a famous historian brought by Hernan Cortez to Mexico, while approaching Cholula with the Spanish army, was amazed with the beauty and brilliancy of the town. Cortez, the Conqueror, names 400 churches and hermitages, to give an idea of the size of this town at the time it was built. Cholula is called the "Rome of the Anahuac" for the architectural richness of its churches.

Cholula—the place where the water is hidden—was probably the capital of the "Ulmeca" civilization, and some historians believe that its inhabitants inherited their artistic skill from the Toltecs. At the present time Cholula retains her most precious architectural jewels built by the Indians and those built by the Spaniards during the Domination.

The Mexican Pyramids

The Pyramid of Cholula, erected to the Aztec God of Goodness, "Quetzalcoatl," is 54 meters high and 459 meters wide at the base. The size of its base makes it the largest monument of its kind in the world, superior to the Pyramids of Cheops and "Chefren." Its proportion between its base and its height is approximately the same as those of Egypt and it is without doubt the highest of the prehistoric temples.

Baron of Humboldt observed that the Pyramid is perfectly orientated according to the direction of the meridians and parallels. From what is known about the Toltec culture and the advancement of the inventors of the Mexican calendar, we presume that this Pyramid was one of the principal astronomical observatories of the Indian priests.

During 1594 a Catholic church was built on the top of this Pyramid instead of the temple existing there. No tourist can call himself one who has not seen Antique Mexico. Mexico is your neighbor and the construction of our modern highway system will make access possible to the most exotic and beautiful places, where tourists will find the most varied and romantic legends in the world. We consider our road program not only National, but Pan-American, and even international, and especially tending to a good understanding between neighbors of the North and of the South. What more could be expected than better mutual intelligence and understanding between Mexico and the United States, Mexico and Central America than the construction of highways which allows such close relations and daily interchange as that, for instance, enjoyed today by the United States and Canada? One thing that we must sincerely hope to achieve with our highway program is to make our relations better and closer with the great American people.

CONTROL OF MATERIALS AND RESULTS

By H. S. Mattimore*

IN THE fabrication of any structure, consideration must be given to the fact that its service efficiency will be controlled by many factors, such as suitable materials, skill of workmanship, and of observance of proper precautions controlling good construction. Engineers who investigate pavements or other structures for reasons of defect or failure find that in the large majority of cases it is difficult to trace the failure of an efficiently designed structure to any one cause. Usually, as is the case with poorly controlled construction, a combination of several or all probable errors or evasions can be traced.

Our present discussion is specialized on materials control and the results in Highway Work. An examination of the Highway specifications of any large organization will readily show that material qualities are one of the essentials in such specifications. As these specifications are changed, as a result of experience we observe that if anything the sections dealing with material qualities are elaborated upon. Therefore, are we not justified in concluding that the use of good materials is considered a major factor in construction? We cannot conceive, at this age, of engineers expecting to obtain an efficient concrete road slab with poor cement or structurally weak aggregate, or a satisfactory bituminous surface with unsuitable material. Some years ago experiments of this kind were tried unintentionally either through inefficient supervision or lack of knowledge. The results of such construction in general were found to be unsatisfactory, as our present state of knowledge leads us to believe would be the case.

An Interesting Example

I had an opportunity to observe several of these conditions—for example—a State Highway Department constructed a concrete road in the outskirts of the city using local sand as a fine aggregate. About a year later the city department constructed the continuation of the same road. To make a more interesting example, the same contractor built both roads, with sand from the same source. The coarse aggregate in both cases was stone of a very good quality. About three years after placing, large sections of the City road were a total failure, while the entire road surface constructed by the State was in excellent condition. Many causes were given for the failure of this road, but the most persistent one was the use of a poor quality sand. The use of a sand from a local pit was commented on by some commercial material producers from the standpoint that no good results could be expected from using material from the so-called wayside pit, but somehow or other the State did secure sand from such a pit which made concrete that gave very efficient service value. A detailed examination of the local sand pit demonstrated that it was possible, without proper control of the material being produced, to obtain an unsatisfactory aggregate, and the probabilities are that the quality, grading and silt content of the sand was a major factor in the failure of the City road.

A Comparison of Aggregates

An example illustrating another phase of this problem—during the year 1919-1920, in our own State we constructed one mile of concrete road with a local stone aggregate. A study of the surrounding ledges convinced us during the construction of the Highway that the stone was of an unstable character, therefore, the concrete on the five miles of the remainder of the contract was constructed with stone from another source. Both sections of this contract were constructed by the same contractor, under the same engineering supervising personnel, and other than the change of coarse aggregate, the same materials were used. About the third year after completion, the section with the unstable aggregate showed signs of surface rupture. This has been progressive and at the present time, some five or six years after completion the road is kept in suitable condition only at heavy maintenance cost. Meanwhile, the section of concrete with the sound stone aggregate has been in excellent shape for the entire period at average maintenance cost. Constant control, close observation of construction, detailed inspection of the quarry, and of the surrounding exposed ledges, no doubt saved five miles of this road, of which the increased cost of maintenance alone would probably pay for material control on a number of projects.

Other examples of this kind could be quoted, but usually many other factors enter into the cause of failure to complicate the conditions making it difficult to definitely trace the effect of any single cause.

The service value of thousands of miles of Highway surfacing under heavy traffic and the difference in service value of Highway constructed under different engineering supervision where all other conditions, such as specifications, climatic and subgrade conditions are essentially the same, as a major argument for competent inspection of which competent material control is an essential part.

Material Control

Material control is a safe insurance for the use of specified materials. Preliminary tests are es-

*Presented Before the American Road Builders' Association.

sential, but are of little or no value unless some positive check is maintained on the material actually being used. I have never seen a specification for any structure which does not specify material qualities in more or less detail. Such specifications without control may and in many cases do fall short of their intent. For example—in bituminous mixed pavements we specify both the grade and quality of the bituminous materials and aggregates to be used. We know that considerable increase or decrease in the quantity of bituminous material will lead to a failure, and other variations from specifications will have this effect on the service value of the pavement. Experience has taught the Highway field that with this type of construction detailed inspections on the quality of the materials and the mixes are absolutely essential. The reason for this can be readily observed when we compare the results obtained with this type of road in large cities or State Highway Departments, which have efficient engineering inspection organizations, with other municipalities where inspection is of secondary consideration and of the political brand.

The use of portland cement concrete as a surfacing has led to a large amount of research or concrete and its constituent materials. Many designs for mixtures have been formulated and tried with more or less success. Proportions and grading of aggregates are the foundation of many of these design theories, and their application required competent material control.

Water Cement Ratio Design

The water cement ratio design, which has been advocated as a concrete quality measure from the standpoint of economy and its ease of application, is applied by maintaining a constant ratio between the water and the cement content to obtain given strengths. An increase of water without increasing the cement proportion would unbalance this ratio and produce a concrete of lower strength. To produce concrete of the maximum strength the water content should be reduced to the amount required to make a workable mix. The amount of water necessary to produce a workable mix, the cement proportions remaining constant, depends to a large degree in the grading of the aggregate, therefore, it seems reasonable to conclude in the application of this theory that an efficient control to assure the use of well graded aggregates is an economic measure.

The cost of operation of a Material Division whose duties include the testing of all aggregates and supervision of full material field control will vary to some extent at different locations. These costs will be regulated by the type of organization, geographic conditions, and the location of the general material sources of the State, but ordinarily these costs should not exceed five-tenths per cent of the cost of construction, and under some organizations where accurate cost has been kept they have been found to run well under this figure. So considering such operation as an insurance for good construction, it is certainly obtained at low premium rate.

It hardly seems necessary to further emphasize the importance of material control from the standpoint that if it is considered essential for good construction to definitely specify material qualities, why not make these specifications of some value, and be assured that the materials actually used are of the qualities specified. To function economically materials specifications should be based on a thorough investigation so that we definitely know that materials of such quality are or can be produced within reasonable hauling distance.

Slab Strength of Surfacing

A step in advance was made in Highway Engineering within the past year or two when consideration was given to the opening of portland cement concrete roads to traffic, based on the slab strength of the surfacing. A trial in our State of this procedure on selected roads in different locations has convinced us that it is a distinctly forward step. Transverse field tests are made on concrete specimens cast from the mixture being placed, and as a result of these tests we can definitely determine the traffic carrying capacity of the slab at different periods and regulate the traffic accordingly.

As a result of research of portland cement concrete and its constituent aggregates, we are finding that the slab strength of the concrete road surface is regulated by many different factors, that is, water content, the kind of aggregates, efficiency of the curing and the temperature and humidity conditions at the time of placing and during curing periodfs. These conditions vary on different contracts, in fact under competent control the least variance is found in material quality, but the other factors are of such importance and are so difficult to control that the concrete being laid on different contracts will show variation in transverse strength. The one big future problem for the Highway Engineers is to try and secure concrete of uniform quality on all his projects.

Some of these factors are phases of design, for instance—different types of aggregates are available for concrete construction, tests indicate that one aggregate gives higher slab strength than another. If this factor is fully established by research now under way, it seems we might give consideration to classifying the roads made with these different aggregates and obtain a differential in bid-in locations where traffic conditions would warrant us using a concrete of lower slab strength made with the weaker aggregate.

A Differential in Final Pavement

Some Highway organizations have established a differential in final pavement to the contractors, depending on the riding qualities of the road surface as rated either by straight edge measurements, profilometer ratings or rating of riding qualities obtained with other devices. Other Departments test finished roads for depths and deduct for shortage. These are rating qualities of a road which although built under inspection are the direct responsibility of the contractor. We have heard considerable talk within the past few years, and some specifications have been based on the idea of making a contractor fully responsible for the finished work and demanding that it meets certain test qualities before acceptance. At the present time this may or may not work out in practice, as it is doubtful if we have arrived at the stage in Highway work where we can expect the contractor to stand fully responsible for quality tests, although I do believe that he can control with good workmanship some of the factors which affect the quality.

A feature that is very notable in Highway construction is that roads built by different contractors under practically the same engineering supervision are not always deserving of the same rating. I do not refer to major defects or deliberate evasions in specifications, etc. What I especially refer to is at the final inspections at different roads, when a comparison is made one is found to have exceptionally good rating while an adjoining road may come within specification allowance and yet is not comparable in finished detail with the first one.

The reason for the higher rating on the first road can be traced to variation in workmanship and a general pride in results on the part of the contractor and his employees. Many times it has been noted that the general aesthetic conditions, such as neat slopes, and general appearance is better on one road than another. These are items that are covered by general clauses in specications, and are difficult ones to attempt rectifying after the work is finished, the general impression being that they are minor details, but every engineer who has responsibility for the final acceptance of any Highway contract realizes this. Many times he probably wished some provision existed by which he could either penalize careless constructors or reward the competent contractor who takes pride in his work and always has competent employees.

Public Knows Riding Surfaces

The traveling public have become educated to differences in riding qualities of different road surfaces, which exist even in roads of the same type. Highway engineers within the last few years are giving special attention to this phase of construction. Some departments as mentioned above penalized the contractor by deducting from his final payment for surface irregularities as rated by specification requirements. The next forward move should be to rate the entire road, taking into consideration quality of mixture as affected by mixing, placing and curing, determined by transverse tests for concrete, and density, toughness and absorption limit in Bituminous mixes, riding qualities of all types of surfaces, shoulder and slope finish, which add to the efficiency and appearance of all highways.

Rating of this kind for acceptance would encourage the contractors who take pride in their work and get good detail workmanship, and penalize the class of contractors who work along the lines of only doing what they are forced to do by supervising inspectors, which constant objections to performing operations definitely called for in the specifications. Fortunately on big operations in highway work of the present day the contractors in the obstructionist class are in the minority, but they still exist. Moves toward their elimination should be encouraged and would be welcomed both by contracting and engineering associations.

I feel that the general contractor's answer will be that the present system of awarding public work to the so-called lowest responsible bidder does not encourage the best work on the part of a contractor. The correction for this can be along the line of a better interpretation of the term, "responsible bidder," which at the best, apparently from the legal standpoint, is anyone who can furnish a bond and has control of sufficient capital to carry on the work. Correction of this kind can and eventually will be made through the contractors' associations with full support of the engineers.

Selecting a Safe Detonator

Unless a charge of explosive is completely detonated injurious fumes, unexploded powder, incomplete work, and fatal accidents may result. The grade or strength of the electric detonator should be determined primarily by the explosive with which it is to be used, according to the Bureau of Mines. Although all industrial explosives are designed to detonate completely with number 6 detonators, these explosives deteriorate under improper storage, and certain classes (gelatin dynamites), by ageing, become insensitive to detonation. This insensitiveness through ageing does not always proceed with the same rapidity even in explosives of the same class. Accordingly, it is recommended by the Bureau that the number 8 detonator be always used with those classes of explosives that may become insensitive through ageing. Detonators of less strength than number 6 should never be used.

FALLACY OF UNNECESSARY STRENGTH

EXCESSIVE and unnecessary strength in the use of mortar in the tremendous building program throughout the country during the present year has cost the nation millions of dollars that might have been expended in new and needed structures, according to an extensive survey of the construction field by the National Lime Association (and discussed in detail in a bulletin entitled "The Fallacy of Unnecessary Strength"). This waste and extravagance is influencing the slackening of building operations; is retarding the building program and, in a broad sense, has its effect upon the general prosperity of the nation, it is asserted in the bulletin, which adds:

There is no place where the fallacy of unnecessary strength runs to more foolish extremes than in mortar. Certain materials have been promoted so vigorously on the score of their high strength, usually known by laboratory tests only, that many builders have slipped into the mistaken idea that maximum strength is the only consideration. Field tests, or even laboratory tests of large specimens are usually lacking, and the lessons of generations of practical experience forgotten in the glamour of superlative strength claims. Also, the cost is usually in line with the claimed laboratory strengths.

During 1924 there were 7,844,363,000 bricks used in the United States. It is safe to assume that during 1926 there will be at least 8,500,000,000 used. In common bond these bricks require 4,725,000,000 cubic yards of mortar. A fair average price for the materials in a cubic yard of 1:3 mortar is $9.40 if Portland cement plus 10 per cent of lime is used, $7 with a 1:1:6 lime-cement mortar, $7.25 if bricklayers' cement is used, and only about $4.75 if lime is used. It costs as much to mix one kind of mortar as it does another, so that cost of materials makes a fair comparison. There are cases where the higher strength obtained by adding some Portland cement to lime mortar is necessary, but these cases would hardly total 25 per cent.

This saving alone would be enough to build from 1600 to 3300 homes costing $5,000 each year—and the country needs the additional homes far more than the wasted strength in other structures. In addition to the saving in cost of materials, there is a saving in time by the use of lime mortar, for the number of bricks a man can lay is governed on the job by the workability of the mortar. According to Dingman's "Estimating Building Costs" (1923), the average workman can lay 1400 bricks per 8-hour day in a 12-inch wall (common bond) when he is using lime mortar, but only 1200 when he uses a cement mortar. Using the same figures as before the time required would be:

Cement mortars	531,250 days
Lime mortar	455,360 days
Saving if straight lime mortar is used	75,890 days

This saving would be equivalent to continuous employment for 316 men for twelve months, working twenty full days every month. If the bricklayers were paid at the rate of $1.50 per hour, their time would be worth $910,680. Also, for every hour of bricklayers' time which is saved there would be one hour of common labor time saved for the men who serve the bricklayers. Consequently, there is the additional saving of 75,890 days of common labor time, which at the rate of $0.90 per hour would amount to $556,400. If lime mortar were used, this saving would be:

Bricklayers' time	$ 910,680
Common labor time	556,400
Materials	16,479,500
Total	$17,946,580

This saving does not take into consideration additional costs of insurance, overhead, etc., important items to the builder.

Any building code will permit a loading of at least 90 pounds per square inch on brickwork laid in lime mortar. Most codes permit 100 pounds per square inch and some permit 125 pounds. The recent report of the Department of Commerce Building Code Committee—"Minimum Requirements for Masonry Wall Construction"—states that when allowance is made for eccentricity and concentrated loading, bending, etc., a loading of 135 pounds per square inch is safe. Recent tests on ordinary good clay brick construction, made on sections of 8-inch walls laid up in lime mortar and broken at the Rock Island Arsenal, showed an average 28-day compressive strength of 695 pounds per square inch. Similar results were obtained on wall specimens tested at the Bureau of Standards.

The wall sections tested at the Rock Island Arsenal were checked to determine what loads had to be applied in order to produce a measurable settlement. The deformation found, even under heavy loading, was so small that it could not be determined on a building during construction, for a single grain of sand would be more than enough to compensate for the slight variation. If the lime-mortar wall one day old was 5 feet high, it would require the erection of 12 feet more of new wall the next day in order to produce a total settlement of 1/32 inch, or less than an ordinary grain of sand.

Lime mortar continually increases in strength, gradually changing into limestone surrounding the sand grains, making a binder which is frequently

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AMERICAN ROAD BUILDERS' ASSOCIATION HOLDS TREMENDOUS MEETING

CHICAGO was taxed with the twenty-fourth annual convention of the American Road Builders' Association and the Annual Road Show, January 10, 11, 12, 13, 14, 1927. More than 20,000 came including producers, contractors, highway officials, engineers and manufacturers. The sessions of the Association were held at the Palmer House and the exhibit was held at the Coliseum.

The machinery exhibit was of the same huge proportions as last year. The latest developed and most highly improved machinery and materials used in the construction, maintenance and operation of roads was on display. The Portland Cement Association and the National Lime Association attracted much interest with their booths. The U. S. Department of Agriculture had a large space, with interesting and well displayed charts. The U. S. Department of Commerce, U. S. Bureau of Public Roads, Canadian, Alaskan, Dominican Republic, Mexican, Highway Research Board, Amercan Association of State Highway Officials and State exhibits were in the Palmer House along the entrance to the session hall.

Henry G. Shirley, president of the American Road Builders' Association and chairman of the State Highway Commission of Virginia, opened the general session on Tuesday morning in the Grand Ball Room of the Palmer House. Mr. Shirley praised the Federal Aid System and said that congressional curbing of funds for the co-operation with state highway departments was an error.

"The proper practice of economy is a most worthy undertaking but when it is applied to a development that will bring in such rich returns as has been secured from the co-operation of the Bureau of Public Roads and the State Highway Departments in the construction of the main highways of this country then such economy in holding down the amount to be appropriated by Congress seems to be ill-advised."

President Shirley predicted an increased Federal appropriation for highways in the near future, "Our great body of congressional law makers will realize the value of modern highways," he said, "and when they do the appropriations for Federal Aid will undoubtedly be increased."

"The need and demand for more improved highways, as well as the widening and improvement of those already being built, was never greater than now," Mr. Shirley said. "In every country the people are looking to such undertakings knowing that prosperity in a large measure depends upon good roads."

"The question of whether it pays to improve highways has been answered and there is not a man or woman in a village or hamlet that cannot answer this question in a most affirmative manner," he continued. "I do not believe there ever was an industry called upon to meet as many new conditions in the same length of time as the highway industry. These changes have been met and solved in such a way that highway construction and maintenance is being carried on today as economically as any other industry.

"Highway construction in the United States has gone beyond the $1,000,000-a-year mark and there is every indication of an increase rather than any reduction, but notwithstanding the only source from which there has not been a general increase has been federal aid. This has been due partly to the so-called economy campaign being carried on in Washington."

Mr. Shirley said the custom of levying a tax on gasoline, now so universally used in various states has met with almost popular approval and seems destined to be the main source for highway construction funds. He said in his opinion there is no reason why a car should not be licensed for the life of the car, thus avoiding the great rush that occurs annually in obtaining license plates, eliminating the large expense of issuing the plates, as well as a great deal of time and trouble for the people.

One of the most important problems confronting the road builders is the proper control of traffic over the highways, according to Mr. Shirley. "It may be said by some that this is not a function of the road builders," the speaker said, "but I believe it is just as much a function of the road builder as it is to build them. Traffic control must be solved in a practical way and there is no class of men better qualified to solve it than the members of this association."

The president introduced Governor Len Small who addressed the assembly. The Governor congratulated the American Road Builders' Association on the splendid exhibits at the Coliseum and adjoining buildings. He concluded with an outline of the Illinois highway situation.

"Illinois has a total of 4,500 miles of high type pavements on our state bond issue road system and a large additional mileage on out state aid or secondary road systems, all of which is maintained by the state," the Governor stated. "The entire cost of construction and maintenance on out state bond issue roads has been paid by automobile license fees."

J. L. Harrison, Highway Engineer, U. S. Bureau of Public Roads, was a speaker on the morning program Tuesday and presented an excellent paper entitled "Increasing Efficiency in Highway Construction Organizations." The competition between contractors was the background of this discussion. Many of Mr. Harrison's remarks apply to conditions among producers.

Studying the Market

"The market—the price at which others will do a given piece of work—sets the price which you, as a contractor, can obtain for doing it. To get the work you study the market—that is unavoidable. You cannot get dirt at 30 cents if your competitor will do it at 25 cents. You cannot get concrete at $3.00 if the fellow whose office is next to yours is willing to do it for $2.00. You have to meet him on the $2.00 price or go out of business! It doesn't make a particle of difference whether you think you can get a profit at that price or not. You have to take it at that price if the other fellow will or you have to go into some other business! And, like the farmer referred to above, after you get that $2.00 concrete you may be no better off than Betsy and the bear. You have all heard of Betsy—she who so blithely called on brother Tom to help her catch the bear and then, having caught him, called mightily to the whole town to come and help her turn him loose!

Competition and Efficiency

"No, to get a job you don't spend much time in estimating the cost of doing it. But you spend a lot of time in speculating on what Harry—or perhaps it is Tom—is going to bid on it and also as to whether the market price is likely to go up or down. That is unavoidable under our competitive system. But after you have gotten the job, you want a profit—a good profit. But to get it—that is a very different thing! Now that pencil which was supposed to have been used so skillfully in making the estimate on which your successful bid rested, but which was really used only when the proposal sheet was filled out, can be called on to as tonishingly good advantage. To obtain that profit the highest efficiency must be had. And efficiency is not accident. Neither is efficiency a synonym for energy or enthusiasm. As a matter of fact, efficiency ordinarily results only from careful systematic planning, from the determination of some specific course by which a desired result can be had and then from setting about with tireless persistence to follow that course. No, efficiency is not an accident. It is, if you please, the result of good management and management means head work and had work—and lots of both of them.'

Planning Operation

"Now that last concrete paving job was taken at $1.95 because you were certain that Harry would bid a shade under $2.00. At that price, it is going to be necessary to cut all the corners to obtain any profit at all. There must be efficiency in every operation and nothing can be lost. But to bring this about, the first thing that must be done is to prepare a plan of operation—a definite course to be followed—which, if followed, will obtain the desired results. A good plan of operation tends strongly to protect profit. A poor plan throws away profit before even so much as a pick is stuck into the ground. In a brief discussion such as this, the details of planning cannot be treated at any length. It may, however, be remarked that to the successful execution of a contract, a plan is as essential as sailing directions are to a mariner. The plan is not a haphazard thing. It is the result of careful thought of what result must unavoidably follow this or that or the other course of action and involves the selection of that course of action which, on the basis of mature deliberation, can be shown to offer the best prospects. The plan should be specific—it should state definitely what will be done, when, and in some instances, why."

Profit Leakage

"There are, after all, only a few points at which a job can go wrong. Take this concrete paving job as an illustration. Where are the points at which the profits can leak out? There are only six of them:

1. The materials may cost more than was anticipated.

2. The yield from the materials may be less than it should have been.

3. The number of men employed may exceed the number planned on.

4. The wage scale may rise.

5.,The number of hours work actually obtained per day may be low.

6. The production per hour—that is, the number of batches turned out per hour—may not agree with the production plan.

Each of these six fields is totally separate and distinct. They do not overlap. The causes affecting losses in one of them have no necessary relation with losses in any other. They therefore offer a specific basis on which to rest the plans for prosecuting this job—the basis on which to rest the plans for prosecuting this job—the basis on which to determine the "how" of getting a profit. Each of these fields must be examined and a calm, calculated determination made of what must be done here if the desired cost is to be had. Thus:

Materials for the last job cost..........95 cents
Those for the new job will cost.........92 cents
The yield last year was............2.15 sq. yds.
The yield this year should be.......2.20 sq. yds.
Last year's crew contained..............56 men
This year the crew must be cut to........52 men

The daily payroll, last year, was..........$196.00
The daily payroll, this year, must be held at 180.00
Last year the time worked per day averaged ....8.2 hours
This year the working day must average 9 hours
Production per hour last year was........80 feet
This year production per hour must be kept to ....90 feet

Efficiency No Accident

"The thought it is desired to emphasize is that every highway job can be divided into specific, practically independent fields and that with past performance as a guide, the question must be frankly raised as to what improvement it is possible to obtain in each and how it is to be obtained. Let me say again that efficiency is no accident. 'Do the best you can, Bill,' is no basis for job control. The management is responsible for the plans. Bill, the superintendent, is responsible for their execution. But before Bill can be held for a profit on that job, somebody must have thought his way through that job clear to that profit, must know what that profit should be, and exactly what to do to get it! That, in short, is the construction plan.

"More in detail, this plan should tell Bill just where and just how this job is to be handled and where the handling of this job is to differ from the handling of the last job and just what results are expected. And the plans must not only be workable—they must be made to work. Bill must understand that explanations and excuses never pass as legal tender at the bank—that his sole responsibility is results.

"To assist him in obtaining these results and to assist you in maintaining a close check on whether these results are being obtained, a job schedule should be prepared. Such a schedule will show just how much of the work should have been completed at the end of each week or of each half month or other specific period. Weather losses must, of course, be given due allowance but after they have been given due allowance it is entirely possible to predict the course of the job and to hold it to this course. Production can fall below schedule only if the hourly rate of production is low, or the number of hours worked per day is low, or whole days are lost by lax management and poor field control. If there is lax field management and the job lags, about the only solution is to get rid of Bill and to find a better superintendent.

Too Much Time Lost

"It really is astonishing how much time can be wasted by a lax superintendent. Last year the records collected on a group of half a dozen projects, lying in the same rain belt—time losses chargeable to rain and to wet subgrade being about 20 hours in each case—showed other miscellaneous time losses which amounted to from 27 hours to 120 hours—12 full days or almost half of a normal month. Production during this same month ranged from 155 hours to 225 hours. Average daily production—after taking out all weather losses—often is as low as 8 hours, is not infrequently as low as 7 hours and sometimes falls as low as 6 hours out of a 10-hour day. Ordinarily such conditions are due to sheer managerial laxity—indifference on the part of superintendents to the proper planning of their work, the growth of time wasting practices in going to and from the job, the tendency to knock off early after a good run, etc. Indeed such conditions are so prevalent that if it were not known positively that the superintendent who got 225 hours of work out of his men on the job referred to above, got along with them better than the man who got 155 hours of work during the same month, it might seem reasonable to assume that customs dictate some of the time wasting practices in vogue on so many construction jobs. But the facts appear to be otherwise, so the conclusion is that the correction of managerial laxity in the field administration of construction work—principally better planning of the field work and the eradication of time wasting practices—rests squarely on the management and presents today one of the outstanding fields in which to work for greater efficiency.

Using the Working Hours

'There is, of course, no escaping the fact that if the mixer turns out concrete or the shovel loads wagons during only 8 out of the 10 working hours, production necessarily suffers. Moreover, the fact that there are jobs where 8 hours work are done during practically every period of 10 working hours rather definitely precludes any argument that this cannot be done. The facts secured would, I am sure, surprise a good many contractors, if a reliable man was placed on each job to report confidentially the exact minute the first charge went into the mixer in the morning and at noon; the exact time the last batch went in at noon and in the afternoon and the length and cause of each delay exceeding 5 minutes. I am not a believer in 'gum shoe' tactics in management but the studies of the Bureau of Public Roads in this field reveal so much laxity in the matter of the actual utilization of the full working day—so much of a tendency to allow difficulties of one sort or another to become an excuse for shutting down the primary producer on a job before they in fact constitute a reason for so doing—that the conviction persists that responsible contractors do not have the facts in their possession or they would take drastic remedial action.

Proper Personnel and Equipment

"It has been noted that production can fall below schedule only if the rate per hour is not secured or if the number of hours worked is low. Both of these should be carefully studied by the contractor and the factors controlling the situation appraised before these rates are established. But while the matter of managerial laxity can be covered in this way, the matter of the hourly rate of production cannot. To attain any given rate of production the equipment must be made available and the proper personnel provided. On a paving job the contractor may reasonably demand, and actually can obtain, from 9 to 9½ hours of production out of every 10 working hours after allowing for weather losses and if he does not get it he can feel reasonably certain that lax superintendence is the basic difficulty. He may also, if he is working a 5 bag paver on standard Maricopa section pavement, ask for a production of 90 feet an hour or even 95 feet an hour. These rates are entirely practical where a minute mix is used and have been attained on properly equipped jobs, but the superintendent cannot possibly secure such a rate of production if some unit in the equipment sent to the job has a capacity which is below this.

Load Factor

"This brings up the matter of load factor. Perhaps that term demands a word of explanation. It really is not a term much used in highway engineering. Electrical engineers all understand it because they have become accustomed to the idea that in power distribution the possibility of profitable operation is vitally affected by the amount of load carried and its distribution throughout the day. So they invented the term load factor. If a power plant is working at a load factor of 50 that means that it is producing and distributing 50 per cent of its rated output capacity. The load factor, then is a measure on a percentage basis, of the use which is being made of the equipment. Now in electrical power distribution a high load factor commonly spells good profit and a low load factor a loss because operating costs are determined by the nature of the equipment rather than by the amount this equipment is producing. A 100,000 K.W. power plant needs no more attention when operating at a load factor of 70 than when operating at a load factor of 20. There is some difference in fuel consumption but all other operating costs remain pretty nearly constant.

Bureau of Public Roads Studies

"Last year the Bureau of Public Roads conducted studies on a steam shovel job where for some time shovels capable of rather easily taking out 600 to 700 yards of material a day were actually producing less than 100 cubic yards of material a day were actually producing less than 100 cubic yards a day. Of course, the cost of merely digging and loading this dirt—none of which could have been rated as more difficult than fair common—exceeded 50 cents a cubic yard merely because the load factor on the shovels was low.

"Low load factor is a common thing in the concrete paving field, also. Probably it is equally common in other branches of highway work but grading and concrete paving are specifically mentioned because they have been subjected to rather careful study by the Bureau. It is no uncommon thing to find that a concrete paving job is operating under an equipment set up which limits the load factor to 50 or 60 on all but the shortest hauls. In paving work the commonest cause of low load factor is inadequate hauling equipment. Low load factor in grading work commonly is the result of either or both of two causes—poor design and poor job planning. The engineer who introduces into his grading plans occasional elements of long haul yardage creates a condition which is peculiarly effective in lowering the load factor. No contractor is equipped to maintain a high load factor against both long haul and short haul. Inevitably he must either sacrifice load factor on his shovel or on his hauling equipment, or work out an arrangement which sacrifices something on both. The point it is desired to emphasize is that, particularly in grading work, the design itself may set a limit on the load factor that can be secured, and that design in this field is today of a relatively low order. Contractors would avoid many losses if they would study the load factor imposed by the design as affecting production with whatever outfit they will use if the work is secured, before bids are entered. In this way jobs so poorly designed that their cost must unavoidably be high can be avoided."

Colonel William G. Edens, president of the Illinois Highway Improvement Association, called on all highway commissions and engineers to use every possible precaution to stop the killings of the automobile in his discussion of Safety on Highways.

Ben H. Petty, Assistant Professor of Highway Engineering, Purdue University, presented one of the most interesting papers and it appears in full elsewhere in this issue.

Local highway development was discussed by Colonel Woolsey Finnell of Tuscaloosa, Alabama, and he stressed the usefulness of the local highway and the importance of the location and population in this usefulness.

Roads and Vision

"If the topography of the country is such that it is necessary to have stiff curves and heavy grades, roads should be located and constructed in such a manner that at least two hundred feet of vision can be had on all curves and at peaks of grades, with proper warning signs near each end of all curves, at crossings and other danger points. Too much attention cannot be given to the width of roads and in securing rights of way wide enough for what the future may demand. A few years ago we thought sixteen feet wide enough for an ordinary road, then sixteen feet paving or hard surface with two-foot shoulders, now we require on our ordinary dirt roads twenty-four to thirty feet width. Local paved or gravel roads should have a minimum of eighteen feet surface and not less than nine-foot shoulders on each side. With the principal centers of trade, county seats, etc., as the hub, all roads should extend to the rim of the county, like the spokes of a wagon wheel.

Consideration to Connection Counties

Due consideration should be given to connections with the neighboring counties, and of course always using all State or Federal aid roads in the county as the most important spokes of the wheel. After these main local roads have been built, then using each of them like the main stem of the leaf of the "Magnolia Grandiflora"; lateral roads should extend from these stems to every farm or small community in the county.

These lateral roads should always point toward the main stem at an angle of as nearly 45 degrees as possible where the topography of the country will permit and the established communities can be served.

Where the land is level and the roads already established along section lines this cannot be done, but as a French Mademoiselle would say, the lateral roads would Zig-Zag. However, in most of the southern states roads have been located along the lines of least resistance and little difficulty will be met in carrying out the first suggestion. Generally the above plan fits in well with the community centers, i. e., churches and schools, and also serves the most important factor in the life of the rural community, the rural mail route. Of course it is an axiom that this would be the ideal condition for the people to reach their markets with their garden, poultry and dairy products.

T. Warren Allen, Chief, Division of Control, U. S. Bureau of Public Roads, discussed the "Control of Construction Unit Costs Through Design." Mr. Allen pointed out the fact that scientific study of construction methods has brought out new machines and new systems which have speeded up the work and reduced the unit cost. George F. Schlesinger, Director, Ohio Department of Highways and Public Roads, and H. E. Breed, consulting engineer, also addressed the same session.

Some of Mr. Allen's remarks are of value to the producer, particularly those having to do with production costs.

"Again, the items of proportion and time of mixing are determined without giving much attention to the strength of the concrete needed to withstand the loads to come upon the pavement. The highway engineer should take cognizance of these and similar things, and constantly study the activities in which he is engaged for the purpose of discovering how they may be brought to a more efficient state, and take steps to introduce the necessary betterments. I believe that a more aggressive attack on the important problems confronting the highway engineer will also do a great deal towards enhancing his professional standing.

'Let us now give consideration to another effect of design on construction costs, that of haul length. This is a matter of importance to all sorts of construction, but it seems to be of greater immediate moment in the grading field than in other phases of highway work. The first thing that strikes one on any extended study of the salient features of grading work is that it divides naturally into two distinct categories. There are, first, digging and loading, and, second, transporting. It is not of interest here to trace the line of demarkation down through such tools as the fresno and the wheel-scraper, though this can be done readily enough on a perfectly rational basis. Rather, in developing the effect of design on cost, it is better to take an equipment set-up where the demarkation is clear, as in the case of the elevating grader or the power shovel on the one hand and the teams and wagons on the other.

Double Production

A power shovel requires a given crew for its proper operation, no matter what output is being secured. Depreciation is not much affected by the amount of material handled during any given time. Even the amount of fuel used falls only slightly as the rate of production drops. The same condition is to be observed in the operation of a concrete mixer. The one man who runs the mixer cannot be cut to half a man if a batch is run out every 2½ minutes. The mixer runs along at a steady pace whether batches are put through it at the proper rate or not, so wear and tear are little affected by the utilization made of its working time. Perhaps a little less fuel is burned when the drum runs light, but the difference is slight.

These illustrations could be multiplied but to do so would be merely to add emphasis unnecessarily to the fact that in the highway fiield each piece of equipment generates an operating cost which is pretty constant, so much so in fact that if a contractor sends out a power shovel or a mixer or an elevating grader or even a plow or a fresno, he has for the job to which this equipment is sent added a fixed item of daily expense that is just about as constant and just about as rigid as the employment of another laborer at fixed wages per day. The contractor can discharge the laborer, but while he is on the job he will draw his wages every day he works. The contractor can also discontinue the use of the shovel but as long as it is in service it, too, will generate its regular cost every day it operates and constantly accumulate depreciation charges.

Basic Unit Production Cost

Now, the limiting output capacity of any piece of equipment or combination of equipment and the operating cost of that equipment are the controlling elements in determining what may be called the basic unit production cost. To illustrate, let us assume that the output capacity of a steam shovel is 1,000 cubic yards a day of a given kind of material, and that its operating cost in that material is $75 per day. There is not time enough available to develop here a justification for either figure. To do so would hardly be of value, but whether they are correct or not they will illustrate the theory involved as well as any. But if 1,000 cubic yards per ten-hour day is capacity production for this shovel in the given material and $75 is its proper daily operating cost, it follows that the basic unit production cost for loading this dirt with it is 7½ cents a cubic yard. Moreover, this cost can only be reduced below this figure by reducing the daily operating cost, for in the nature of the case, 1,000 yards per day being the full capacity of that shovel, output cannot be increased except by rebuilding the shovel, which, in fact, makes of it another shovel.

Wage Scales Affect Basic Cost

The basic unit production cost will vary a little from place to place because differences between prevailing wags scales will somewhat alter the daily cost of operation. The cost of fuel also varies as do the other items which comprise the daily operating cost. However, the greatest current differences in regional wage scales, in fuel costs, etc., though in themselves important are not great enough to make it possible to establish any basis for the belief that such differences will cause the basic unit production cost on this particular work to vary more than a cent or two a cubic yard from the mean. The basic unit production cost is, of course, based on the correct use of labor, fuel, etc. It presupposes that the hauling equipment is so supplied and handled that no shovel time is lost. There is, therefore, little possibility of improving this basic production cost by modifying the personnel or the utilization of fuel, etc., on a given piece of equipment, but improvements in equipment do affect it. Finally, as general economic conditions change, wage scales rise or fall and with these changes the value of commodities generally is somewhat altered. This naturally affects the cost of operation and so affects the basic unit production cost.

Efficiency Can Be Determined

There are two points it is desired to bring out through this method of presentation. The first of these is that, for any given piece or group of pieces of equipment, there is for a given set of conditions a basic unit production cost which is the lowest unit cost obtainable with that machine or that combination of machines. To reach it requires merely that equipment be worked at full output capacity, properly manned and properly served. In short, it becomes a standard with which actual results may be compared and operating efficiency thus determined.

The second point is that, though the basic unit production cost is not a fixed thing, varying as it does from place to place and from time to time, the variations are relatively small for such equipment as power shovels, elevating graders, concrete pavers, etc. Fegional differences in wage scales are considerable, but when these are applied to a correct personnel set-up for a piece of equipment of this kind, their effect on the daily operating cost is so small that the basic unit production cost is little affected. The same must be said of variations in economical conditions. These changes are important—that is true enough—but the commonly accepted engineering view that they are vital, for example, to low cost steam shovel or elevating grader production, can hardly be substantiated when the facts are analyzed in this fashion. Variations of 10 per cent in some cases perhaps as much as 20 to 25 per cent, are encountered but it is not such variation as these that account, for instance, for the fact that there are regions in this country where grading for highway work commonly costs less than 20 cents a cubic yard and that there are regions where it often costs over $1.00 a cubic yard.

Labor Wastes Not Serious

Neither can such differences as these be sufficiently explained by the incorrect use of labor, fuel, etc., in such regions. Rather extended studies of highway construction practices do show that there is a good deal of variation between the correct and the actual use of labor, fuel, etc., variations which have the effect of making actual production cost higher than it ought to be. But such incorrect practices are not limited to the high cost regions. Therefore, these differences, like those to which reference has just been made, may be dismissed as relatively of minor importance, taking highway construction work as a whole and as it exists today. The man who uses an extra man on his shovel and pays him $4.00 a day increases basic unit production cost only a little more than 5 per cent. This is, of course, a waste which tends to reduce profit, but wastes of this sort are not the most serious wastes in the highway field.

Efficient Equipment Important

To find the really serious wastes in most lines of our present highway work we must inquire not into the reason why one pays a little higher wages or uses more labor or more fuel than another, but we must turn our inquiry into such lines as will tell us why one man in one place consistently maintains his output close the limiting capacity of his equipment, while another in some other place, but, under reasonably identical conditions as to equipment and materials, rarely succeeds in maintaining better than 50 per cent of the limiting capacity of his equipment. In short, the really important question in searching for lower construction costs in several important lines of highway work, therefore, is not the cost of the supplies but why the production of our highly specialized equipment so seldom even measurably approaches its limiting output capacity. In other words, the cost of much of our highway work is fixed not by the output capacity of our equipment, but by the rate of efficiency with which this equipment is operated.

The Bureau of Public Roads has been studying this problem, both extensively and intensively, for some time and as a result has come to the conclusion that there are a number of specific causes of low production. On the contractor's side of this problem, the first of these is the common failure to coordinate the capacity of interdependent equipment. On concrete jobs this is apt to express itself more definitely as a failure to provide enough transportation to keep the mixer supplied but it may be a failure to provide loading facilities which operate with sufficient speed or the use of trucks which dump too slowly, etc. There are a considerable number of points at any one of which a failure to coordinate may cause under-production.

Dan J. Parrish, President, Illinois Association of Highway and Municipal Contractors, presided at a session on Tuesday devoted to the general subject "Contracting as a Business." J. H. Ellison, President, Associated General Contractors of America, presented a paper on "Contractor and Constructor Defined." A. E. Horst, Secretary and Treasurer, Henry W. Horst Company, discusses "What Is a Fair Profit in Highway Construction?"

Pan American Day was observed on Wednesday moning. F. Diaz Leal, Commissioner, National Highway Commission, Mexico, presided jointly with Colonel R. Keith Compton, Director, Department of Public Works, Richmond, Virginia. Delegates from South America, Central America, Alaska and Canada were in attendance. Canadian Highway Problem was discussed by E. A. James, Chief Engineer, Toronto and York Roads Commission. The Highway Situation in Mexico was discussed by Andres Ortiz, Department of Communication, Mexican National Highway Commission. This paper is presented in full elsewhere in this issue. Road Construction in Cuba was described by Manuel Alberto Coroalle, Construction Engineer, Department of Public Works, Havana, Cuba. The Chilean policy of highway construction, finance and maintenance was explained by Benjamin Cohen, Secretary to the Chilean Embassy.

Sessions were also held on Wednesday for discussion of construction problems and also practical operating problems. C. S. Avery, Chairman, Oklahoma Department of Highways, presided at the Construction Section while Edward McCrady, President, Associated Pennsylvania Contractors, presided at the other.

E. F. Kelley, Chief, Division of Tests, U. S. Bureau of Roads, presented a very interesting paper on the recent developments in highway research which is presented elsewherei n this issue. Mr. Kelley presented his paper before the Constrution Section. B. H. Piepmeir, Chief Engineer, Missouri State Highway Commission, presented a paper on the Latest Improvements in Construction Methods. Leslie Ramer State Highway Engineer, North Carolina State Highway Commission, discussed contract control and engineering service. H. S. Mattimore, Engineer of Tests and Materials Investigations, Pennsylvania Department of Highways, discussed Control of Materials and Results.

R. C. Jacobs, President, Juniata Paving Company; W. M. Wilmore, Vice President Wabash Construction Company; A. F. Johnson, President, A. F. Johnson and Company; and Robert E. O'Conner, J. C. O'Conner Sons, addressed the section on practical operating problems.

Two sessions were held on Thursday. One of them concerned operation and maintenance while the other dealt with the enlargement of the contractors' field benefiting political sub-division. All States' Day was the final session of the convention and it was a general one. Four excellent papers were presented. J. T. Ellison, Assistant Commissioner and Chief Engineer, Minnesota Highway Department, presented a paper on Best Method of Control and Payment for Pavement Quantities; Two Thousand Years of Road Building, was presented by Thomas H. MacDonald, Chief, U. S. Bureau of Public Roads; Frank T. Sheets, Chief Engineer, Division of Highways, State of Illinois, presented a paper on Practical Qualifying of Bidders on Public Works; and Should Engineers' Estimates Be Made Public? by Arthur W. Brandt, Commissioner of Highways, State of New York.

Charles M. Babcock, Chairman of the Minnesota State Highway Commission, yesterday was elected president of the American Road Builders' Association to take office in May. He will succeed Henry G. Shirley, Chairman of the Virginia State Highway Commission as chief executive of the Association. Mr. Babcock has been active in affairs of of the American Road Builders' Association for many years, and was a member of the Board of Directors at the time of his election. He is well known and respected throughout the highway field. He is observing and capable, with a quiet force that marks him as an intelligent leader.

A group of new directors were elected to fill expiring terms. Three vice-presidents were re-elected and another selected from the board of directors.

The vice-presidents are: Sam Hill, Honorary Life President of Washington Good Roads Association; S. F. Beatty, President, Austin-Western Road Machinery Company, Deputy Engineering Executive, Pennsylvania Department of Highways; S. T. Henry, Director, Pan-American Federation for Highway Education.

Sen. James H. MacDonald, New Haven, Connecticut, was re-elected treasurer of the Association. The directors elected were J. R. Draney, Asphalt and Oil, New York City; Richard Hopkins, Contractor, Troy, New York; Edward E. Duff, National Paving Brick Manufacturers' Association, Cleveland; A. E. Horst, Secretary and Treasurer of Henry W. Horst Company, Rock Island, Illinois; T. A. Little, Vice-president, Harrison Engineering and Construction Company, Kansas City; Fred R. White, Chief Engineer, Iowa State Highway Commission.

Study of Liquid Oxygen Explosives

In the course of a general study of liquid oxygen explosives, the Bureau of Mines, Department of Commerce, is investigating the effect of physical and chemical properties of combustible absorbent materials and wrappers on absorption and retention of oxygen, explosive properties and formation of carbon monoxide, and applying the results of this fundamental knowledge to blasting under mining conditions. Tests of a number of brands of fuse developed as a result of similar tests last year, have resulted in a better understanding of the effect of low temperature on the burning rate of fuse and of the requirements of a fuse for use with liquid oxygen explosives. Cooperative work along development lines is being conducted with a manufacturer of fuse. The relation between oxygen content of the cartridge and explosive strength has been investigated and the effect of purity of oxygen on explosive properties of liquid oxygen explosive cartridges has been determined.

The Bureau is also determining the physical properties as, for example, rate of detonation, disruptive force, etc., of liquid oxygen explosives prepared by the section on laboratory research, and is determining the most efficient types of liquid oxygen explosives for field uses.

Practical application of fundamental data obtained at Pittsburgh has been made in actual blasting at the mines of the Compania de Real del Monte y Pachuca, Pachuca, Hidalgo, Mexico; Whitecap Mine, Yak Tunnel, Leadville, Colo.; and mines of Cero de Pasco Copper Corporation, Cerro de Pasco, Peru. Here it was shown to be possible to blast with liquid oxygen explosives without formation of harmful quantities of carbon monoxide providing cartridges of correct density were used and the round fired within eight minutes.

Bituminous Macadam Pavements*

THE question has often been asked, "Why is it that so much research and so much effort has been devoted to the development of the designs of roads of the rigid type with practically no corresponding effort on roads of the semi-rigid or flexible type." Unquestionably, one answer to this query is that we are all prone to undertake the easiest problem first, perhaps as a stepping-stone to the solution of the more difficult problems. In dealing with the rigid type of roads we have dealt with materials, which in the parlance of theoretical mechanics have elastic properties, as contrasted with the inelastic or plastic properties possessed by the materials used in the construction of roads of the non-rigid type. All who are familiar with the mechanics of materials know that our knowledge of the so-called elastic materials is much more definite and much more highly developed than is our knowledge of the mechanics of plastics.

We have, therefore, been handicapped by the many apparent difficulties in our way in making a study of the structural design of the non-rigid types of roads. However, we should not be deterred from undertaking a problem because it seems difficult, for the mere setting down of the known facts often clarifies the atmosphere and results in the stepping forward of others with more highly developed knowledge along the required lines. I am thus led to the recording of the facts which seem available and which might serve to initiate the development of a stronger and more economicla design for the flexible type of road, just as intensive thought and intensive research have resulted in improved design for roads of the rigid type. In undertaking a problem of this nature it is well to consider its various phases and particularly is it well to think back to fundamental principles. For the purposes of simplification let us confine ourselves to one flexible type of road and let that type be the bituminous macadam.

When an engineer first begins to think of the design of any kind of structure whether it be a bridge, a building, or a highway, he asks himself what are the forces which must be withstood by the structure and what are the properties of the material out of which the structure is to be built. Too frequently, however, when an engineer thinks of a highway, he thinks alone of the surfacing as being his entire highway structure. When it is remembered that heavy loads from vehicles are transmitted by the surfacing to the subgrade material and that it is the subgrade which ultimately supports the heavy loads of traffic, it is quite apparent we must consider our structure of consisting of:

1. The subgrade.
2. The surfacing material.

*From a paper presented by A. T. Goldbeck at the Fifth Annual Asphalt Paving Conference.

PIT AND QUARRY FOREIGN DIGEST

Spraying Concrete

Portable apparatus for spraying mortar comprises a mortar receptacle, a nozzle in connection therewith and means for introducing a jet of compressed air into the nozzle near its mouth, the mortar being drawn into the nozzle and ejected therefrom by compressed air. O. Granier (British Patent 259,896).

Building Blocks and Slabs

Building slabs or plates are formed by fitting notched bars running in two directions at right angles to a rectangular structure with box-like pockets, applying facings to one side, then fitting diagonal stays across all the pockets and filling them with a heat insulating substance such as slag concrete or wood concrete, and finally applying a facing to the remaining side and all around the edges. Mathmak Ges (British Patent 259,936).

Preserving Stone

Natural and artificial stone, concrete, etc., is hardened and preserved by treatment with a volatile silicon compound in the presence of water. Suitable compounds are silicon tetrachloride, tetrafluoride, oxychlorides, disulphide, disilicon, hexachloride, silico-chloroform, silicon methane, silicon methide, etc. These substances may either be applied by spraying to the previously moistened stone or they may be dissolved in water and the solution applied to the stone. Other substances, e. g., sodium aluminate, may also be dissolved in the water. The volatile compounds may also be used in conjunction with a solution of silicic acid. De Ros & Barton (British Patent 260,031).

Excavating, Dredging

In an excavator or dredger having a frame or back member provided with a cutting edge and adapted to be drawn to and fro by an engine on each side of excavation by haulage ropes, etc., attached to the frame at or near the top and bottom, the depth of cut being adjusted by adjusting the relative tension of the top and bottom ropes to tilt the frame, means are provided for automatically adjusting the tension of the top and bottom ropes when the machine is pulled in the reverse direction so as to tilt the frame to an angle sufficient to discharge the load. Mornement and Ray (British Patent 260,128).

Abrasive Cement

An abrasive cement for joining blocks of sandstone together to form grinding stones consists of 90 parts by weight of sand, 10 parts of Redmanol or other synthetic resin, 3⅓ parts of furfurol, and 2½ parts of ethyl alcohol. The proportions may be varied but the amount of furfurol should not exceed one-third the synthetic resin. H. O. Keay (British Patent 260,171).

Fibrous Concretes

Building blocks, etc., are molded from a mixture of fibrous material such as peat or sawdust and cement containing lime or to which lime has been added, and are then treated with dilute sulphuric acid to promote the setting of the composition. Surplus acid may be subsequently removed by washing. J. Melandri (British Patent 260,313).

Cleaning and Preserving Stone

Stone, metal and other structural materials are treated in order to clean and preserve them by applying a solution of caustic soda or other alkaline sodium compound, and hydrogen peroxide or sodium peroxide in the presence of moisture. The stone is wetted with the solution, or solid sodium peroxide is applied and wetted with water, and the surface is kept wet for about an hour by spraying with water or steam at intervals, and then washed with water. In an example given, the material is wetted with a 2½ per cent solution of soda soap, and a 30 per cent solution of hydrogen peroxide is applied, followed by a 50 per cent solution of caustic soda. The surface is kept damp for an hour by brushing with a wet brush, and finally scrubbed or sprayed to remove the solution. J. E. Marsh (British Patent 260,331).

Slab Walls

Walls are formed of flanged concrete slabs of story height, the body of the slabs consisting of dense concrete and the flanges of breeze concrete reinforced by bars. The slabs are assembled side by side and set in grooves in a foundation. Mitchell & Stewart (British Patent 260,372).

Cement Sprayers

A cement-spraying apparatus comprises an ejector, connected to a flexible suction pipe the lower end of which is provided with means of admitting air. The means may comprise a constricted terminal having perforations at the constriction, through which air is admitted by a pipe. The ejector is provided with an inducing nozzle slidably mounted in a gland and adjusted by a screw. W. J. Tennant (British Patent 260,424).

Portland Cement

In the addition of gypsum to Portland and like cements, precautions are taken to prevent the conversion of gypsum into plaster of Paris by the heat of the clinker. The precautions may consist in (a) cooling the mill in which the clinkers and gypsum are ground together, (b) cooling the clinker before it is ground with the gypsum or (c) adding ground gypsum to the previously ground and cooled gypsum. Apparatus is illustrated for performing the third modification. Pontoppidan & Buntzen (British Patent 260,447).

Acid-Proof Slabs

Acid proof slabs, plates, etc., for lining metal vessels are made either of pure fused silicon or of the compositions, consisting of pulverized silicon and water-glass cements. I. G. Farbenindustrie A. G. (British Patent 260,575).

Pitch-Concrete Mass

Concrete from sand or other pulverized material and pitch are used as the bender for production of objects of all kinds, coverings, linings, etc., which must be resistant to chemical as well as mechanical influences. The concrete is mixed with a special amount of carbon free hard pitch which softens only at high temperatures, about 110 to 160 degrees, C. Continentale Prodorit A. G. (German Patent 434,779).

Ferrous and Aluminous Cements

The theory which attributes the hydraulic properties of Portland cements to tricalcium silicate and tricalcium aluminate is incorrect. The calcium silicate compounds are much more complex and contain several Si atoms. The author also believes that tricalcium aluminate does not exist in Portland cements and that the compounds found in clinkering are ternary, consisting of $A1_2O_3$, SiO_2 and CaO. Hydraulic properties are essentially an attribute of lime. When BaO and SrO are substituted for lime in compounds otherwise similar to cement, the hydraulic properties are lacking. The author has found that hydraulic calcium aluminates can be prepared without fusion, and even without clinkering, making possible the production of aluminous cements at a cost much lower than that of ordinary fused cement and about the same, or slightly lower than Portland cements. Raw materials for this purpose consist of bauxite, waste sludges from $A1_2O_3$ plants and cinders from pyrites furnaces. They are burned at 1100-400 degrees and are discharged in a powdery or slightly clinkered form. Mortar made from cement in this form is very refractory and stands well the highest temperatures ordinarily encountered. Ernest Martin Mon. scientifique, 16, 97-101 (1926).

Alumina From Natural Silicates

When clay is heated with sodium carbonate solution sodium aluminum silicate and free carbon dioxide results as follows:

$$A1_2O_3.\ 2SiO_2.\ 2H_2O + Na_2CA_3 \qquad Na_2O.\ A1_2O_3.\ 2SiO_2. + CO_2 + 2H_2O.$$

This reaction is non-reversible. On cooling in the closed vessel the carbon dioxide reacts again with the sodium aluminum silicate and forms alumina and Silicic Acid which at the high temperature dissolves only slightly in the soda solution. The filtered soda solution always contains bicarbonate formed from the CO_2 and excess soda. A factory for the manufacture of alumina by this process is being erected in Czecho-Slovakia. H. Kassler (Chemiker Zeitung 50, 917, 1926).

How to Be a Failure

There are so many "success stories" going the rounds just now that it seems to us a few instructions on "how to be a failure" would not be amiss. Just adhere to the following instructions and there will be little doubt as to your ultimate end.

1. Don't Advertise. Advertising is the bunk and should be forgotten. Let your competitor throw away his profits if he wants to—but you keep yours. Particularly should advertising be thrown overboard when business is a little slack.

2. Put your prices high, but forgot about quality. Perhaps some of your customers will object to this, but you should worry. There are lots more.

3. Be Surly. This rule should apply to both employees and customers. It is a mark of manliness to show everyone that you are afraid of no one. Bawl your employees out in public and whenever possible be discourteous to customers. Then everyone will say: "Isn't he a whiz!"

4. Give credit to anyone asking for it. And don't be in a hurry for the money. Your customers need it just as badly as you do.

5. Always be behind in your payments. What's the object of taking the 2 per cent discount when you can get 3 per cent at the bank. Never let anyone bully you into paying your bills. Remember, they need the business.

6. Don't go to conventions. What's the use of sitting around a stuffy hotel, listening to a bunch of wind-bags. Besides, it costs money.

7. Never exhibit your product. These machinery exhibits and shows are getting too thick. Nobody attends them anyway except the exhibitors, and you can't sell to your competitor. Why pay a lot of money just to see a lot of people walk by a booth?

8. Never take inventory. You have a pretty fair idea how you stand anyway. Why go to all that bother?

DEVELOPMENT IN INDUSTRIAL STANDARDIZATION DURING 1926

NOTABLE developments in the industrial standardization movement, including important progress in the mechanical and mining industries, in industrial safety, its further extension through managerial and trade association activities, and forward steps in international cooperation, have been achieved during 1926, according to an announcement of the American Engineering Standards Committee, which states that standardization was the subject of a special report at the recent conference of the premiers of the British Empire.

Instead of leaving their standardization work as a more or less incidental function of the engineering and production departments, industrial executives are more and more providing a definite organization for their standardization work. This was well illustrated during "management week" when scores of meetings of industrialists and Chambers of Commerce, held all over the country, were devoted to the consideration of the standardization and simplification problems which are met by the works' manager and his associates.

The systematic organization of company standardization work is leading to a much larger degree of cooperation between companies. For example, in the Cleveland industrial district the men in charge of this work for a large group of important companies have organized for mutual assistance in the work. Through this more than thirty Cleveland firms have reorganized their screw thread practice in accordance with the revised national standard, and more than a dozen firms have systematized their entire control of interchangeable manufacture through the introduction of the new national standard of limit gaging.

International Cooperation. In April there were held in New York the most important group of international conferences on standardization ever assembled. Of these the two principal features were the meeting of the International Electrotechnical Commission with its group of technical committees, and the Third Conference of the National Standardizing Bodies, in connection with which there were international technical conferences on screw threads, ball bearings, gages, and preferred numbers. In each of these technical conferences real progress was made toward bringing about international uniformity in industrial practice in the different countries. Twenty countries from Europe, Asia and South America were officially represented.

During the conferences a basis was laid for what it is hoped will soon become a unified international standardizing body covering the general field of industrial standardization. In September, committees of the two groups met in London, at which time further steps were taken. Final agreement upon a unified plan has not yet been consummated, there naturally being difficulties inherent in a problem involving a group of national as well as international organizations. The relation of the International Electrotechnical Commission, a specialized organization, to a general standardizing body, into which work from the national industrial standardizing bodies shall feed, is of special importance in this country.

Government Activities. The fifth year of Mr. Hoover's Division of Simplified Practice shows steady development. About 50 simplifications have been carried through. These include a wide range of commodities from bed springs to shot gun shells, and from milk bottles to range boilers. In a survey of 19 of these commodities it is stated that from 51 to 99 per cent of the sales are in accordance with the simplified practice recommendations, the average of the 19 being 79 per cent.

The unification of Government specifications under the Federal Specifications Board has now reached a point where the main lines of Government commodities are covered. More than 400 specifications have been approved, and a considerable number have reached the second edition. While contact with industrial groups has been maintained in the work, to a very considerable extent through the A E S C, much yet remains to be done in thoroughly coordinating these Government specifications with those in general use in the industries.

The Bureau of Standards has proposed an interesting plan of certification under which any manufacturer who is willing to supply goods made to comply with a given Government specification, may file with the Bureau a statement to that effect. Consumers upon request will be given a list of such manufacturers. This plan has been widely discussed in a large number of organized industrial groups, since this proposal in some form may ultimately have far-reaching effects upon sales policies and upon our present method of distribution.

Mining Standards. The work of the Bureau of Mines, the American Mining Congress, and of other organizations, on safety rules for installing and using electrical equipment in coal mines, has been unified under the procedure of the American Engineering Standards Committee and formally approved as an American Standard. The work of the sectional committees on drainage of coal mines, outside coal handling equipment, and wire rope for mines, has all been practically completed, and it is expected will be formally submitted for the approval of the A E S C in the near future. A particularly important piece of work, which is being considered as the result of a representative conference of interested groups held in Pittsburgh, is the classification of coal as a basis of industrial commercial transactions. The work will cover all grades of coal from lignite to anthracite.

Mechanical Standards. The work of the sectional committee on tooth form of spur gears, which has been in progress for several years, has been completed and has been submitted for the formal approval of the A E S C as a Tentative American Standard. Several parts of the comprehensive work on bolt, nut and rivet proportions, are now nearly completed, and the same is true of several sections of the work on pipe flanges and fittings. It is expected that the first of these to be issued will be that on high pressure steel flanges which, although not yet officially completed, is already practically the sole basis of industrial practice in recent advances in high pressure steam practice.

The work on mechanical standards now in the course of development under A E S C procedure is so extensive that plans are under way for the organization of a representative advisory committee to keep the various parts of the work properly coordinated.

Railways. More than a hundred million railway ties are produced in this country yearly. During the year specifications satisfactory to both the steam railways and electric railways have been agreed upon for the first time. It is an interesting illustration of the manifold inter-relationships of modern industry that eleven national organizations were officially represented on the sectional committee through which this unification of specifications has been accomplished. Specifications for tubular steel poles and for girder rails have also been unified and approved as Tentative American Standards.

Safety Codes. Twenty of the fifty codes on the national safety code program have now been approved by the A E S C. Among those receiving approval during 1926 were a group of codes for the prevention of dust explosions, and new editions of the codes for abrasive wheels and punch presses. A particularly important development has been the revision of the "National Electrical Code," which is the industry's bible for wiring devices. This included a settlement by almost unanimous action, of a controversy of three years' standing, over the admission, as approved material of non-metallic sheathed cable. This new material was approved for limited uses.

In connection with the safety code program, and upon the initiative of the state industrial commissions, arrangements have been made for a revision of the standard plan of reporting and compiling accident statistics under the procedure of the American Engineering Standards Committee. This plan forms the general basis of the accident statistics of the various state governments and of the casualty insurance companies.

Construction Costs Decline

Construction costs declined slightly during 1926, reaching the lowest average occupied in any year since 1922, according to statistics compiled by the Associated General Contractors of America and announced today. The tendency toward lower cost levels, in force since mid-summer of 1923, continued to make itself evident. The year was conspicuous for slight fluctuation in the cost of construction, virtually a single level being held throughout the last five months of the year. Earlier the cost figures had consistently refused to approach the higher levels of 1925.

The average of costs for 1926 was slightly less than twice as great as the 1913 average, holding the 1927 level on an index which takes the pre-war year's average as its basis. The 1925 average was 199, while the 1924 figure was 202. The lowest mark reached during 1926 was quoted in October, and the highest level was assumed in May, the respective index figures being 195 and 199. The December figure was 196.

The decline in the average cost of operation last year was largely the result of decreases in the prices paid by general contractors for basic materials entering into their operations. The average of these prices paid during 1926 showed a drop of five points from the index figure of 183 established in 1925. The average of wages paid by contractors in the principal construction centers of the United States during 1926 was slightly more than the corresponding average registered for 1925. The 1926 average occupied the 225 level, one point above the plane held by the 1925 average.

When Securities Are Unsafe

In his book "What Price Progress," Hugh Farrell makes this statement which we believe merits not only the deep consideration but the action that must follow conviction:

"The world moves on and the industries which do not keep pace lose the coveted place in the front ranks of progress. The chemist, the physicist, the engineer and the technologist, are showing the way; those representatives of science in industry are extending and consolidating the gains that were made by the production engineers and quantity experts of yesterday.

Their field is now; they are just beginning to astound the world with the results they can produce. The industry that attempts to go forward without their guidance risks as much as a ship without a rudder, and its securities are not safe investments."

QUARRY ACCIDENTS IN 1925

The stone-quarrying industry of the United States employed 91,872 men in 1925, of whom 52,224 worked inside the quarry pits and 39,648 worked at outside plants on such work as stone crushing, rock dressing, manufacture of lime or cement, etc., states the Bureau of Mines, Department of Commerce, in a review of reports received from operators of quarries, covering accidents and employment in that calendar year. Accidents to the employees resulted in the death of 101 men in the quarry pits and 48 men at the outside plants. The death rate for the industry as a whole was 1.78 per thousand men employed (calculated on a standard of 300-work-days per man), as compared with 1.63 for the preceding year. Accidents to men working inside the quarry pits resulted in a fatality rate of 2.28 as against 1.90 in 1924. For crushing and other outside plants the rate was 1.22 as against 1.24 in 1924.

Of the 101 fatalities among the men working inside the quarries, 34 were caused by falls or slides of rock or overburden, 20 by explosives, 13 by machinery, 11 by haulage equipment, 8 by falls of persons, and 15 by various other causes such as handling rock, flying rock, electricity, etc. The principal causes of fatalities at the outside plants were machinery, haulage, falls of persons, burns, electricity and falling objects.

The reports of injuries that did not result fatally included all accidents that incapacitated an employee beyond the day on which the accident occurred. Among the employees inside the quarries 8,722 men were thus injured, representing a rate of 197 injuries per thousand men employed, as compared with 178 in 1924, an increase of about 11 per cent. The main causes of these accidents and the number of men injured by them were: 1639 by handling rock, 1267 by flying objects, 912 by haulage, 846 by falls or slides of rock or overburden, 764 by machinery, 462 by falling objects, 436 by drilling and channeling, 410 by falls of persons, 335 by timber or hand tools, and the remainder (less than 300 in each case) by explosives, nails and splinters, burns, electricity, and boiler and air tank explosions.

Nonfatal injuries among employees engaged in stone crushing, rock dressing, and other work outside the quarries numbered 5,533, indicating an injury rate of 141 for this group of workers as compared with 171 in 1924, a reduction of about 17 per cent. The principal causes of these accidents and the number of persons injured from each cause were as follows: 1099 by flying objects, 638 by machinery, 568 by falling objects, 471 by falls of persons, 468 by hand tools, 433 by haulage, 397 by handling rock, 280 by burns, 215 by nails and splinters, 81 by electricity, and the remainder by miscellaneous causes.

The total number of accidents of all kinds during the year was 14,404. Of this number 149 accidents resulted in the death of the injured men, 22 caused permanent total disability, 430 caused permanent partial disability, 2,627 caused temporary disability lasting more than 14 days, and 11,176 caused temporary disability exceeding the remainder of the day of accident but not exceeding 14 days. These deaths and injuries combined, when weighted according to standard methods, represent a loss of time estimated at 1,493,000 man days, a loss of time equal to about 6 per cent of the total number of man days worked by all employees during the year. In 1924 the deaths and injuries represented a loss of 1,399,000 man days or 5½ per cent of the total man days worked.

Persons employed at quarries in Pennsylvania outnumbered those employed in any other state. The reports for Pennsylvania showed 18,138 men employes in 1925. Ohio ranked second with 6,620 men. California reported 6,075, Indiana 5,457, Illinois 4,872, Vermont 4,603, and New York 4,390. Other states having as many as 2,000 men employed at quarries were Missouri 3,501, Georgia 2,862, Massachusetts 2,635, Virginia 2,281, Tennessee 2,256, Michigan 2,191, and Wisconsin 2,031.

American Concrete Institute Meets In Chicago in February

Announcement has been made of the twenty-third annual convention of the American Concrete Institute to be held in Chicago, February 22, 23, and 24 at the New Palmer House. The convention will occupy three days instead of four as in previous years.

On Tuesday afternoon, February 22nd, papers and reports on important examples of the field control of concrete will be given with recommended methods for the application of field control. Tuesday evening will be occupied with the problem of reinforced concrete design with emphasis on bridges.

The Wednesday morning program will be especially for the concrete products manufacturer concerned with quantity production of standard building units. Wednesday afternoon the program will deal with ornamental concrete, high quality concrete dimension stone and the use of color in concrete. The problem for Wednesday evening will be architectural achievements in concrete, with emphasis upon the new forms in architecture to which concrete gives expression especially in elaboration of exterior features.

Aggregates and cement will be the topic for consideration on Thursday morning, February 24th. The program indicates three days of extremely interesting and important information and discussion. There is no lost time apparent in the plans of the American Concrete Institute, and the sessions promise to be profitable in every detail.

(Continued from page 85)

The writer believes that pavement widths up to 40 feet are necessary and are the best methods of handling excessive traffic in many communities. However, the parallel road has its place in the dispersion of traffic and in the opening and development of more rural areas. Each specific problem requires individual study to accomplish its proper solution. No general rules can be laid down to cover all cases.

Expenditures Demand Consideration

Highway officials should not be carried off their feet by the noisy and insistent demands for excessive expenditures on pavement widening programs in certain localities resulting in very unfair concentration of highway expenditures in a few districts to the neglect of just demands from other parts of the state. Actual traffic conditions as determined by a state-wide highway transport survey such as those conducted in Connecticut, Massachusetts, Pennsylvania, Ohio and also in Cook County, Illinois, should form the basis of plans for relieving traffic congestion. Only in this way can our highway funds be expended intelligently for this purpose.

We are not confronted by a theory but a reality. Traffic congestion is already threatening the progress of many communities. It behooves the responsible public officials to attack this problem promptly and with the necessary courage and determination to carry out the plans which, from proper consideration, appear to provide the best solution of the problem. Such plans may appear exceedingly ruthless to certain more or less powerful groups and therefore a backing of earnest public opinion should be developed to carry the plans to maturity.

(Continued from page 92)

more permanent than the unit it holds in place. Also, lime mortar gives a perfect balance between compressive strength, tensile strength, and bond or resistance to shear. When used in the wall it gives uniform, even bearing and perfect bedding to every brick, making the most of every surface and binding the bricks together into a solid and uniform mass capable of resisting any forces which a wall must withstand. This uniform and even bedding is extremely important, for it utilizes the full area of the bricks to carry the load and avoid cracking. If high compressive strength alone was necessary, a strip of steel might well replace the mortar joint.

What is required of mortar is to bind masonry units together to make a wall that is strong enough to carry the load. Lime mortar is strong enough; it is plastic beyond any other mortar, and is without competition in price. A wall laid in good lime mortar is safe.

Hand to Mouth Buying a Blessing

WHAT is commonly referred to as hand-to-mouth purchasing is the logical outcome of a completely revised industrial order. Prices have so fluctuated during recent years that long term contracts are precarious for both buyer and seller. Neither group has been able to gauge price trends with sufficient accuracy to make long term commitments advantageous. As the tendency has, in general, been downward, purchasers have been without incentive to place orders for future delivery. Then too, the revision in our industrial order has been further brought about by increased knowledge of business as a science.

Economists can predict, with fair accuracy, general trade trends several months in advance, with the result that large users of raw materials know, roughly, what requirements are going to be over these periods. The years of the World War gave us additional manufacturing capacity which enables us to meet almost any production demand. When demand slackens, manufacturers have no hesitancy in trimming their plants to meet reduced requirements; yet they can meet heavily increased demands without the necessity for a building program or expensive extension. All of which means that warehousing by manufacturers has almost ceased to exist.

Outstanding evidence of the new conditions may be found at the Ford Motor Company—which has no warehouses. That company lets its dealers warehouse the surplus, when there is any, with the result that the interest on $150,000,000 worth of raw materials and finished products is saved. According to an article by Henry Ford, if his company were to operate on 1921 methods, it would today have on hand raw materials valued at about $120,000,000, and there would be in transit finished materials to the value of $50,000,000. Instead of this investment of more than $200,000,000 in raw and finished products, the Ford business is being conducted with an investment of about $50,000,000. This situation is the result of buying and manufacturing for current needs.

Nor is the situation peculiar to the Ford company or the automotive interests, since it exists in practically every line. Business forecasting, shaping production and purchasing to current needs, rapid and well-timed transportation, increased usage of mechanical labor, and the elimination of little used shapes and sizes, are all factors in the new condition.

Long term contracts have largely passed out of style. They were the outgrowth of what might be termed confidence, at best little more than a guess. This has been replaced by business knowledge comprising statistical information on markets, raw materials, production capacity, demand, supply, finance, and the other elements of commercial economics.

Northern Blower Equipment Installed at Peerless Plant

For obvious reasons, chief among which is the dust-nuisance, the average cement mill is generally located well outside city limits. The Peerless Portland Cement Company, however, is an exception, for it is situated within the City of Detroit itself.

For some time the company has been faced with a serious dust-problem. The grinding department in particular, was generally so full of dust that it was almost impossible to see across it when the machinery was in operation. Under such conditions, it was naturally difficult to obtain and hold employees of a desirable grade, in competition with neighboring factories. Even more serious, however, was the escape of dust into the surrounding district. Literally tons of finely-divided dust were spread abroad, particularly on Jefferson Avenue and other streets directly abutting on the plant.

The problem of rendering the plant dustless was peculiarly difficult. Not only must large volumes of dust be removed from the plant as soon as formed, but they must also be prevented from escaping into the open air. The difficulty was sill further complicated by the dampness of the air caused by the moisture and steam thrown off by the 3 inch water-jets which serve to cool off the material in the grinders. In fact, many dust-collecting engineers were of the opinion that the problem could not be successfully solved.

In view of the fact that various attempts had already been made to overcome the dust difficulties at different times the contract for the dust-collecting equipment, which was awarded to the Northern Blower Company, contained very stringent conditions. It was specified that the grinding department was to be made absolutely dustless, and that the system should be erected and operated at the manufacturer's risk until it had definitely fulfilled the requirements to the satisfaction of the management.

An 8-unit Norblo continuous suction air-filter was specifically designed as the collector. This type consists of a series of separate filter units in which the air is cleaned by being drawn through cloth filter bags, each unit being kept in good filtering order by periodical reversals of the air current at intervals of a few seconds apart. This is perfectly practicable to shut down one or more of the units for repairs or inspection without interfering with the filtering action. The pipework also necessitated special design to avoid the risk of the damp dust piling up and clogging in the pipes. This system has solved the problem and it is reported that no trace of suspended material is now found in the air of the department.

Wood Shovel Catalog

The Wood Shovel and Tool Company has recently issued Catalog C describing the Wood shovels, scoops and spades. The plant which produces these articles is claimed to be the largest and most modern shovel plant in the world. Many of the machines used are specially designed for this work, all are electrically operated and arranged for economical production.

In addition to three standard grades of carbon steel shovels this plant also manufactures goods made of a special analysis of carbon steel which are heat treated in order to obtain a longer wearing product. The catalog is very complete, showing the various types and sizes which are manufactured by this company.

Climax Engineering Company Issues New Bulletins

The Climax Engineering Company have issued two new bulletins covering the application of their Climax "Trustworthy" Engines to various types of power. Bulletin K describes power units for driving sand pumps and rock crushers, while Bulletin O covers the use of power units for portable saw mills.

In these bulletins, tables are published showing the power requirements for each industry, with a list of engine models which apply to each set of conditions. The bulletins are illustrated by scenes showing the Climax Engines at work in each of the various fields covered.

Le Roi Merges the Beaver

The Le Roi Company has taken over the business formerly conducted by the Beaver Manufacturing Company, makers of the Beaver heavy duty gasoline engines.

With Beaver's line of gasoline engines, Le Roi Company will now manufacture gasoline engines ranging in horse power from the small 3 to the big 160. The heavy duty Beaver engines have been widely known for their performance and power and have been serving the field for 25 years. The Beaver engines are solely intended for heavy duty service and have a horse power range of 4 to 160. They are made in 4 and 6 cylinder sizes with a bore and stroke range of 4¼x6 inches to 6½x7 inches.

Kent Opens Chicago Office

In line with their program and to better serve the field, the conveying machinery division of The Kent Machine Company, announces the opening of a Chicago office at 625 Monadnock Block, with Mr. F. E. Schwalb as Manager and Sales Engineer.

Mr. Schwalb was formerly connected with The Weller Manufacturing Company in the capacity of chief engineer. His experience in the material handling field also includes that of designing engineer, supervisor of design, and a chief construction engineer.

Foote Appoints

The Foote Bros. Gear and Machine Company has recently made the following appointments: The Banks-Miller Supply Company, of Huntington, West Virginia, as district representative for territory covering the vicinity of Huntington. The Progressive Machine and Engineering Corporation, Richmond, Virginia, as district representatives covering the state of Verginia.

Van Guilder Wallbuilder

The firm of Van Guilder System Concrete Building, Inc., has recently issued the second edition of booklet under the above title. The Van Guilder system is not a new method of construction as over 30,000 buildings have been erected by this method in the United States and Canada. The Wallbuilder is a machine for erecting buildings with double monolithic walls, separated by a continuous air space 2½ inches wide. This method does away with forms of wood or metal.

When building a wall six easy steps are followed: The machine is placed into position, which is easily and quickly done; the machine is next filled with concrete, tamping as it is being filled; after filling and tamping to the level of machine the collapsing bar is then grasped; next by lifting the handle of the bar as far as it will go, the inner core collapses and the outer plates expand, releasing the wall just cast; machine is then held at both ends when it can be slid forward to the next position and by operating the collapsible handle the machine is ready for pouring the next section of wall.

Illustration of several buildings, used for a variety of purposes, are shown in the book with letters from satisfied users of the machine and afford very instructive reading and useful reference.

New P & H Excavator

The Harnischfeger Corporation has just brought out a new ½ cubic yard capacity machine, called Model 300. These machines are built specially for small jobs where exceedingly short tail swing and ability to travel in close quarters, power, speed and reliability are deciding factors. With a tail swing of 7 feet 1½ infhes, a swing speed of 5¼ r.p.m., powered with a 50 horse power gasoline motor, a hoist independent of the swing, a corduroy that can be turned in the tightest places. It can be used with the following attachments: Shovel, dragline, clamsheli, crane pile driver or magnet. For clam service, etc., it is equipped with a 30 foot boom.

Like all larger P & H models, this machine. This model 300 is by no means an untried experiment. With over 13 years' experience in building excavating machinery, with 1,600 of these in service this smaller model 300 will doubtless prove as successful as the larger sizes. A recent test just completed, consisting of over a year's actual stiff service in the field, proved that this model, in proportion to the work done, is a sturdy, powerful, economical excavator.

Half Cubic Yard P & H Excavator.

model 300 is also equipped with the P & H power clutch control. Only 4½ pounds pressure is required to work the levers, the motor doing the rest. Another feature well worthy of mention on this machine is the foolproof boom hoist braking system. In addition to a foot operated band brake and a pawl and ratchet for holding the boom in a fixed position, is a lowering control load brake which positively prevents the bom from dropping. The Harnischfeger Corporation states that this load -brake has been used on P & H electric overhead cranes for over 30 years and never known to fail. The corduroy construction is built along the same general lines as those which have proved successful on the larger models.

The car body is of large proportions, well braced, the traveling machinery being easily accessible. The revolving frame is a heavy one-piece, annealed steel casting, extending from boom hinge to the extreme end of the machine.

Dolomite Incorporates

Effective January 3, 1927, Dolomite, Incorporated, succeeds The Dolomite Products Company. The succession is accompanied by no changes in ownership, management, policies or products.

New Monarch Tractor

The Monarch Tractors Corporation has recently issued a catalog describing the new 10 ton Monarch tractor, model F. This tractor has a capacity of 50 draw-bar horse power. It is built of the unit construction type, four main units; motor sub-frame, motor, transmission and truck. The motor sub-frame is a single heavy casting, the motor being carried within the frame, secured by six bolts.

The motor is a Monarch-Beaver heavy duty type, four cylinders, valve in head type with detachable heads, cylinders cast in pairs. The cylinders have 6½ inch bore and 7 inch strike. The governor is set at the factory for a normal speed of 850 revolutions per minute. The motor is cranked by either the Bendix hand starter located on the steering column, or by the electric starter outfit.

The transmission used is a selective sliding gear type with three speeds forward and one reverse. It is completely inclosed and protected against entrance of dust and against oil leakage by means of gaskets and cork ring seals. The master clutch is of single dry plate type with twin friction surfaces, cast iron against Thermoid linings. The entire clutch is mounted on a pilot shaft through two New Departure ball bearings. The steering clutches are located at the rear and entirely outside of the transmission case. Both clutches are carried on a single clutch shaft of heat treated steel mounted on New Departure ball bearings. Each steering clutch housing is provided with an external contracting type brake, 4 inches wide with Thermoid lining.

The final drive is through two short Baldwin chains, 2½ inch pitch, roller type, from the transmission sprockets to the main chain-drive sprockets. The roller truck frames are of heavy steel beam construction, comprising 8-inch ship-channels, riveted, bolted and trussed. The entire weight of the tractor is carried on to the tracks through 15¼ inch truck wheels. The wheels are mounted on pairs, 4 pairs in each truck roller frame. The truck wheel is a single steel drop forging, machined and heat treated, with inside flange, each pair being pressed on a 2¾ inch diameter steel axle.

As the drive sprocket picks up and carries the track forward one link at a time, the track is supported on idler rollers of drop forged steel. There are 3 double rollers on each side, carried on spring mounted brackets, bolted to the truck frame Each track comprises 24 links of special alloy steel heat treated for toughness and durability. The track links or shoes are 15 inches wide.

S-A Opens New Office

A new Cleveland, Ohio, branch sales office has been opened by the Stephens-Adamson Manufacturing Company at 472 Hanna Building. This district office will be in charge of John G. Stewart and J. L. Langner, both able engineers and well known in this territory.

Mr. J. G. Stewart has been actively associated in the conveying business for many years and has gained an enviable reputation as an engineer of ability and a designer of material handling labor saving equipment. With the extensive line of conveying equipment manufactured by the Stephens-Adamson Mfg. Co., this district sales office should be of great service to those industrial concerns in the Cleveland territory who want equipment for the economical handling of bulk materials. Mr. J. L. Langner, who will be associated with Mr. Stewart, is also thoroughly familiar with this class of engineering.

Bay City Shovels

The Bay City Dredge Works has recently issued bulletin T-2 describing the Bay City tractor shovel and bulletin number 26 illustrating the Bay City 16-B shovel. The former shovel is an economical, fast, one man operated machine for smaller jobs where the larger shovels would be cumbersome. It was designed to fill the gap between hand labor and high priced shovel equipment. It can turn around in its own length. This shovel is the result of several years' study and experiment by an experienced engineer who has designed other smaller and lighter tractor shovels. It is built of special analysis material. It is fast in operation or traveling and can work in traffic or crowded quarters. It is convertible to operate shovel, clamshell, dragline or back filler.

The shovel is powered with an International Harvester Company-McCormick-Deering tractor with cylinders 4¼ inches diameter with a stroke of 5 inches, using gasoline as a fuel. It is fitted with all steel crawler treads of 9 feet full length; three speeds are provided, the highest giving a speed of 3½ miles an hour. The shovel boom is 15 feet long and crane boom 25 feet long with a power boom hoist for both booms. The shovel and clamshell have each a capacity of ⅜ yard, water measure of ½ yard when heaped. The crane capacities are 3,000 pounds at 18 foot radius or 2,000 pounds at 22 foot radius.

The 16-B shovel is described in the catalog as the new Champion of the heavy weight skimmer ditcher class. During the past year this machine has been tried out on various classes of excavation operations and proved its value, and some of these are illustrated in the bulletin. It is claimed that this was the first skimmer with the following features: With gasoline power; with crawlers under front axle; with mast extension to clear front crawlers; with A-frame bearing outside crawlers; with crawlers enclosed on three sides to keep out dirt; to also operate shovel attachment; to provide power boom hoist and separate crane boom; to make all parts accessible; to provide crawler locking device and to provide powerful brakes for all motions.

Electric Controller Devices

The Electric Controller and Manufacturing Company has recently issued two new bulletins describing improvements in electrical devices which this company manufactures. Bulletin 1042-F describes the E. C. & M. automatic compensators for 110 to 550 volt A. C. squirrel cage and synchronous motors. The mechanism of this compensator is a single self-contained unit completely wired, inclosed in a cast iron tank and totally immersed in oil. All line, motor, control circuit and transformer tap terminals are above the oil. The double throw action of the switching mechanism is obtained by a magnet which compresses a spring when the starting contacts are engaged, and a relay which trips a latch when the motor is up to speed, causing the starting contacts to open and the running contacts to close. These automatic compensators are not only suitable for remote control but are used in many places where the service is too severe for the safe operation of hand compensators. With the master switch stationed at a distance from the compensator, the operator is protected from shocks and burns such as are possible by improper starting operations resulting in oil explosions on hand operated starters.

The second bulletin, 1037-C, illustrates type B limit stops for alternating and direct current motors. The principal application of this stop is to prevent overtravel of the hook block on electric cranes. However, it is equally applicable to door hoists, etc., in fact, to any motor driven machine which must be automatically stopped when reaching a given position. The stop includes a limit switch, which is attached to one of the shafts of the operating mechanism, and a magnetic contactor for opening and closing the circuit carrying electric power to the motor. The limit switch controls only the small current required to operate the magnetic contactor. It is in a weather-proof box, with a cover easily removable, and is equipped with grease cups for lubrication at all needed points. The magnetic contactor is maintained in the closed position normally, and when the limit of travel is reached the limit switch opens the contactor, thereby stopping the motor.

Spiral Pipe Catalog

The Naylor Spiral Pipe Company has recently issued a new catalog describing the Naylor Spiral Lock-Seam pipe. It is a profusely illustrated and practical, informative book, which will be useful to those who have need for light weight pipe with a smooth inside to be used for conveying materials, liquid solutions, etc., and who want to know more about the how and why of pipe economy.

The information given will be of use to engineers who have to advise in the selection of proper pipe to do certain work and to engineers and draftsmen who design machinery with which conveyance pipe is used.

New Incorporations

Eureka Limestone Co., Asheville, N. C. $100,000. C. E. Bonesteel, Asheville, N. C.; H. Fleming, Hot Springs, N. C.; L. Blankenship, Lexington, Ky.

Sand Springs Lime Co., Sand Springs, Okla. $5,000. J. S. Greer, Rosie Tracy, Loraine Greer, Sand Springs, Okla.

Little Rock Stone Co., J. W. Carmean, Pres., Little Rock, Ark. $75,000.

Cooper Crushed Stone Co., Inc., Plymouth, Pa. $50,000. (Formerly Geo. P. Cooper Construction Co.) Leased tract near West Nanticoke, Pa., for plant to be ready March 15. Geo. P. Cooper, Pres., and Gen. Mgr.; Myer Freidman, Sec.; Emil Rothman, Treas.

Improved Brick & Stone Co., Wilmington, Del. $500,000. Manufacture brick, stone, and building materials. (Corp. Trust Co., 120 Broadway, New York City.)

Johns-Manville Corp. 100,000 shares, $100 each, 750,000 common, n. p. v. W. R. Seigle, C. M. Swain, H. R. Trainer. (Filed by Davis, Polk, Warwell, Gardner & Reed, 44 Wall St., New York City.)

Rochester Lime & Cement Corp., Rochester, N. Y. $10,000. F. C., W. F., and F. A. Lauer. (Filed by Bly & Bly, Rochester.)

Illinois Silica Co., 807½ Washington Ave., Cairo, Ill. $75,000. Mining, milling, manufacturing and selling of soft or amorphous silica and other minerals, clays and allied products. A. M. Davis, T. J. Peterson, E. C. Sheiden. (Cor., Moses, Kennedy, Stein & Bachrach, 231 S. La Salle St., Chicago, Ill.)

General Gypsum Co., 112 W. Adams St., Chicago, Ill. $5,000. (Delaware corporation.)

Perfection Gravel Sales Co., Shreveport, La. $50,000. T. G. Roberts, J. W. Sanders, 1038 Sheridan Ave.

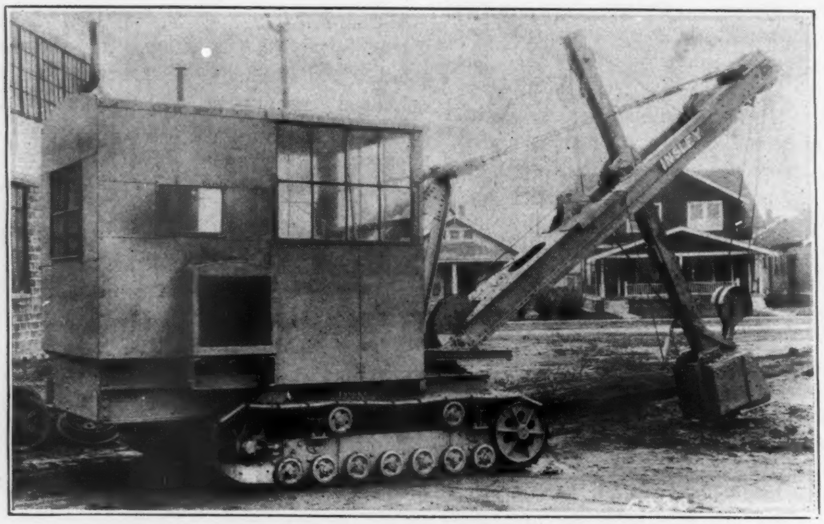
Margerum Rock Asphalt Block, Inc., Tampa, Fla. H. L. Bowlby, R. W. Sanders.

Hercules Motors Personnel

At the annual meeting of the Hercules Motors Corporation held December 20, it was voted that the present officers and directors will continue to serve. They are H. H. Timken, chairman of the board; E. A. Langenbach, president; Charles Balough, vice-president; H. P. Blake, secretary; and as directors, Gordon M. Mather, president Mather Spring Company, and R. W. Gallagher, president East Ohio Gas Company, Cleveland, Ohio.

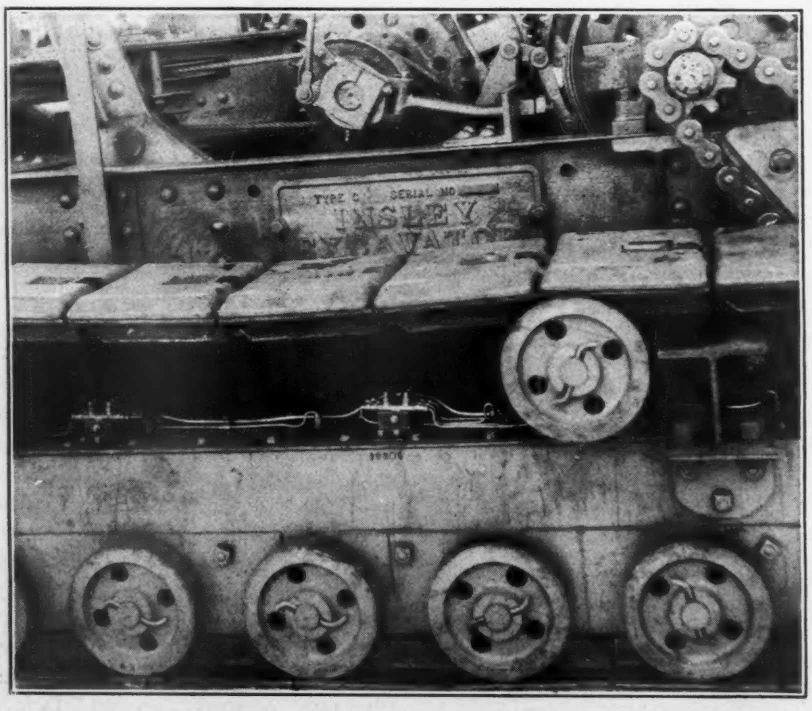
Type C Insley Excavator

The Insley Manufacturing Company has recently made several improvements in the Type C Insley Excavator. The machine can be furnished with a completely enclosed steel cab equipped with swinging windows and sliding steel panels which permits ample light for the operator and complete accessibility to every working part and at the same time effects the desired protection to the machinery.



Type C Insley Excavator.

Another improvement in this machine is the adoption of the one shot lubricating system to crawler rollers. In the past the moving of an excavator under its own power over a long distance has presented something of a problem in keeping the crawler bearings properly lubricated, sometimes necessitating the use of an alemite gun three or four times during a trip of five miles. With the one shot system it is never necessary for the operator to leave his seat to oil these rollers as this system is controlled by a cylinder and plunger mounted in front of the control levers within easy reach of the operator's seat. An addition to this line is a back filler attachment with a 30 to 40 foot telescopic boom, which boom can be extended to a length of 50 feet by the addition of a 10 foot intermediate section.



View of Lubricating System.

Buda Changes Personnel

The Buda Company advises that effective January 1, -927, Mr. H. M. Sloan, as vice-president, will have complete charge of all sales activities. Mr. J. S. Dempsey is appointed treasurer to assume the duties formerly handled by Mr. Sloan as treasurer.

The Gruendler Line

The Gruendler Patent Crusher and Pulverizer Company has published a catalog of the rock and gravel crushing equipment which it manufactures. The all steel jaw crusher is built with a high factor of safety, it is claimed that it has a tensile strength of approximately 100,000 pounds to the square inch. The frame and heavily ribbed swinging jaw are of open hearth cast steel and designed for severe service. The pitman is of the split bearing type for taking up wear. The wedge block, which regulates the size of material desired, can be adjusted either upward or downward while the crusher is in operation.

The Gruendler heavy duty hammer crusher is constructed of steel castings and equipped with special swinging hammer. The shape, weight and number of hammers, and the opening between the grate bars determine the size of material. The double ended hammer is reversible and the straight hammer can be adjusted on the discs to take up wear. The baffler bar and breaker plates are constructed of manganese steel and are reversible and adjustable to take up wear. The grate bars are furnished in single grate bar units and can be removed or replaced one by one. This crusher will reduce large rock to 1½ inches or finer in one reduction.

The Gruendler portable crusher with folding elevator mounted on heavy I beams and steel wheels, can be furnished with or without engine. The entire equipment is self-contained, and the manganese steel die plates are backed up with zinc to insure an even contact with the supporting fall. The buckets are of the continuous type and are constructed of malleable or steel. They are mounted either on a belt or solid pintle type chain, arranged with a small gear hoist for raising and lowering elevator.

This company also manufactures four sizes of portable washing, screening and storage plants. Another product of this company is a self-contained complete crushing plant, complete with screens, bins and elevator all mounted on steel wheels for transportation from one place to another.

MacNeal Issues Bulletin

Donald B. MacNeal has recently published a bulletin illustrating and describing the cranes, draglines, shovels, cars and tracks, locomotives and contractors' equipment which he has for sale or for rent. A large assortment of machines and equipment is shown in this bulletin which are applicable to the pit and quarry industry.

Jeffrey Fiftieth Anniversary

A half century ago, the greater resources of electrical power were yet to be developed and mechanical material handling was in its infancy. Some attempts had been made to elevate and convey materials by machinery, but these were crude and few. In 1877, the Jeffrey Manufacturing Company began the manufacture of a machine for cutting coal mechanically, on which new types of chain for power transmision were used. That machine, the first practical coal cutter was destined to revolutionize the coal mining industry and open the way for the development of chains for many industrial uses.

At about the same time a member of the company then known as the Columbus Rolling Mills came to the little one room workshop of the Jeffrey Company. Noticing several pieces of malleable roller and steel thimble roller chain lying on the floor, he inquired if they might not be used as a drive for the feed rolls in their mill. These chains had been designed for use as drives on the Jeffrey Coal Cutters; however, it was found that they worked equally well on the feed rolls. From this humble beginning the chain department of the Jeffrey Company grew rapidly and these two chains were soon being used for bucket elevators, conveyors and drives in several industries.

The power transmission problem of stern wheel steamers on the Mississippi River added impetus to the development of the chain business. Rubber belts had been used but bolts were susceptible to stretching, slipping and weather deterioration. Two of the first companies to change from belt drives to Jeffrey chain drives on their river boats were the Pittsburgh Plate Glass Company and the Mobile firm, Mahler, Bell and Olinger.

Various companies in industries where materials were moved frequently between processes had been experimenting with sveral types of conveyors. These were principally rope with cross flights for pushing the material, but they were not entirely satisfactory.

Simple chain attachments were soon developed to carry the flights and a new era in conveyors had begun. Other types of chains and conveyors were the natural development. Perhaps the earliest use of Jeffrey Conveyors was by canning companies for handling fruits and vegetables and in strawboard plants as straw conveyors. As early as 1886 the Portage Strawboard Company, the nucleus of the present American Strawboard Company, had in use over two miles of Jeffrey Roller Chain.

Jeffrey Engineers have given to industry many of the most important developments in elevating; conveying; transmision; crushing; pulverizing and shredding machinery. Today, much of the coal which is converted into power to light and warm our homes, drive our machinery and electric railways, and provide many of the comforts we enjoy is mined by Jeffrey coal mining equipment, cleaned ready for shipment in Jeffrey tipples and handled into the power plants over Jeffrey elevators and conveyors and reduced to proper size by Jeffrey crushers.

In fact, Jeffrey Equipment is used in every industry where materials are handled. The present Jeffrey plant covers more than 60 acres of ground. Twenty branch offices carry Jeffrey service to every part of the United States, and many sales representatives extend it to practically every country. The Jeffrey Manufacturing Company is one of the largest manufacturers of material handling and mining equipment in the world. The name Jeffrey on Machinery has come to mean the mark of trustworthy material handling service.

In celebrating its golden anniversary, the Jeffrey Manufacturing Company is to be congratulated on its numerous contributions to material handling progress. Material handling is an important factor in practically every industry. By developing machinery to handle materials mechanically, Jeffrey Engineers have made possible a continuous flow of materials through the process of manufacture which is so vital to quantity production. With the heavier handling tasks lifted from its shoulders, labor is happier and able to increase its earnings. Production has increased many fold, it has been possible in many cases to greatly lower the unit cost.

New Arc Welding Bulletin

The general Electric Company has issued bulletin GEA-569 describing the General Electric Constant-Potential arc welding sets. These sets are designed to generate direct current at 60 volts at all ampere outputs up to their rated capacity. This feature enables several operators to draw welding current from one machine without interference with each other. The desired current and arc voltage are obtained by means of a variable resistor in each welding circuit.

The standard sizes of these welding generators are 400, 500, 750, 1,000 and 1,500 amperes at 60 volts for one hour. The continuous capacities are 80 per cent of these one hour ratings. Standard G. E. motors can be furnished for any commercial voltage, direct current, or polyphase alternating current.

Stephens Adamson Issues New Catalog

Stephens-Adamson Manufacturing Company has recently issued the new number 30 catalog which is complete in its listing of S-A Machinery, both standard and special, as designed and manufactured for material handling purposes. The descriptions give concise information relating to each unit, the blue prints and drawings show typical arrangements and important dimensions, and the tables include specifications and sizes necessary for selecting and for purchasing.

These tables give new data referring to the design, capacities and power requirements of all classes of conveying and elevating machinery. There are also listed those specialties manufactured by S-A engineers which are related to production of material handling equipment.

The catalog contains 960 pages of carefully compiled and correlated listings of machinery units. Over a thousand illustrations and nearly a thousand blue prints and drawings are used to show the equipment. The book is printed on the finest lightweight paper to conserve bulk and the semi-flexible binding lends itself to convenient handling.

New Goodrich V Type Belt

A noteworthy devolopment in mechanical drives is the endless belt of the side-driving type, made of vulcanized rubber and fabric, and a patent has recently been granted the B. F. Goodrich Company covering the construction and method of manufacturing this type of belt. Having its beginning in automobile fan drives, the application of such belts has been rapidly extended to include other industrial purposes.

While engineers have long recognized an inherent superiority in the wedging grip of a V drive over the flat belt type, it was not so easy to devise a durable belt for this service which could be sold at a reasonable price. Progress in rubberized fabric side-driving belts has been marked by several distinct steps, the first of which was taken by the B. F. Goodrich Company when in 1912 they brought out an endless, vulcanized V belt of all cord and rubber construction, later marketed under the name "Silvertown." This belt had an inextensible cabled core and a cover of spirally wound cord strands. It gave excellent service, but was somewhat expensive to make. Goodrich also patented in 1918 a flat belt with a continuous-wound cord center and a bias-fabric cover and in 1921 The B. F. Goodrich Company brought out a rolled, vulcanized fabric belt.

CRUSHERS

Champion 9x15 No. 4.
Champion 10x20 No. 4½.
Champion 11x26 No. 5.
Farrell B 13x30.
Farrell B 18x30.
Farrell B 18x36.
Traylor 24x36.
Telsmith No. 2-F.
Telsmith No. 3-F.
Telsmith No. 4-F.
Telsmith No. 9.
Telsmith No. 16.
McCully 4—5—6—7½K—9.
Kennedy No. 37.
Gates 4—5—6—7½K.
Austin No. 5—No. 8.
Symons 24 in. Disc.

DRAG LINE OUTFITS

Two Sauerman outfits complete. 1—gasoline. 1—electric.

LOCOMOTIVES

Vulcan—60 ton, 6 wheel, saddle tank.
Plymouth—8 ton, standard gauge, gasoline.

GASOLINE CRANE

Byers (Bear Cat) with ½ yd. clam shell bucket.

SCREENS

1—60"x20', 1—60"x24'.
1—40"x16'.

NEW DRAG LINE BUCKET

1—New Hayward, 1 yd. capacity, complete, manganese fitted.

SHOVELS AND CRANES

Steam, Gas & Electric.

A. J. O'NEILL CO.
1524 Chestnut St. Philadelphia, Pa.

FOR SALE

1—70-C Bucyrus Steam Shovel, Railroad Type.
1—Thew Steam Shovel on Traction, ¾ yard.
1—O & S Locomotive Crane with 50 ft.

These are real machines in good working condition, and for sale because of operating changes being made.

LINWOOD CEMENT COMPANY
713 Kahl Building Davenport, Iowa

Machinery for Sale

One 6 ton, std. gauge locomotive — two ¾-yd. and One 1½-yd. steam shovel and locomotive Crane.

Crushing Rolls

One 8"x5", two 16"x10", two 24"x12", one 30"x10".
Two 26"x15", one 30"x16", two 36"x16", one 54"x24".

CRUSHERS

Gyratory

One No. 3 Gates—One No. 4 Gates—Two No. 5 Gates.
Two No. 6 Gates & McCully—Two No. 7½ Gates & Austin.
Three No. 8 Gates & Traylor—One No. 9 Gates—One No. 12 Gates.

Jaw

Two 8"x14"—one 6"x20"—two 9"x15"—one 10"x20"—two 12"x24"—one 13"x30"—one 18"x36"—one 24"x36"—one 48"x60".

Rotary

Two No. 0, two No. 1, one No. 2 Sturtevant Rotary Fine Crushers.

Ring Roll

Two—No. 0, two—No. 1 and one No. 2 Duplex Sturtevant ring roll mills.

Ball and Tube Mills

3', 4', 4½', 5', 5½', 6', 8' Hardine Mills and Tube Mills.

Dryers

Two 3'x20', Three 4'x30', One 4½'x30', One 5'x40', Three 5½'x40', Two 6'x60', One 7'x60' and One 8'x80' Direct Heat Rotary Dryers, One 5'x25', one 6'x30', Two 8'x8' Ruggles Coles type "A" and One 4'x20' Ruggles Coles type "B" Double Shell Rotary Dryers.

Kilns

4'x40', 6'x60', 6'x90', 6'x100', 6'x120', 7'x80', 8'x125'.

Ball and Tube Mills

Hardinge Mills—Two 3', Three 4½', Three 6', Two 8'.
Swing Hammer & Tube Mills—Fuller, Griffen and Raymond Mills.

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1—P & H 206 Crane, 38-ft. Boom.
1—Parsons 36 Trenching Machine.
1—8¼x10 Three-Drum Hoist & Boiler.
1—4½x6 Swinging Engine.
80—Pcs. Arch Web Lack. Piling 26 ft.
250—Pcs. Arch Web Lack. Piling 10 ft.
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3—¾-yd. Dump Buckets.
1—Complete Plant for concrete road construction.
4—4-ton 36 in. Gauge Elec. Locomotives.
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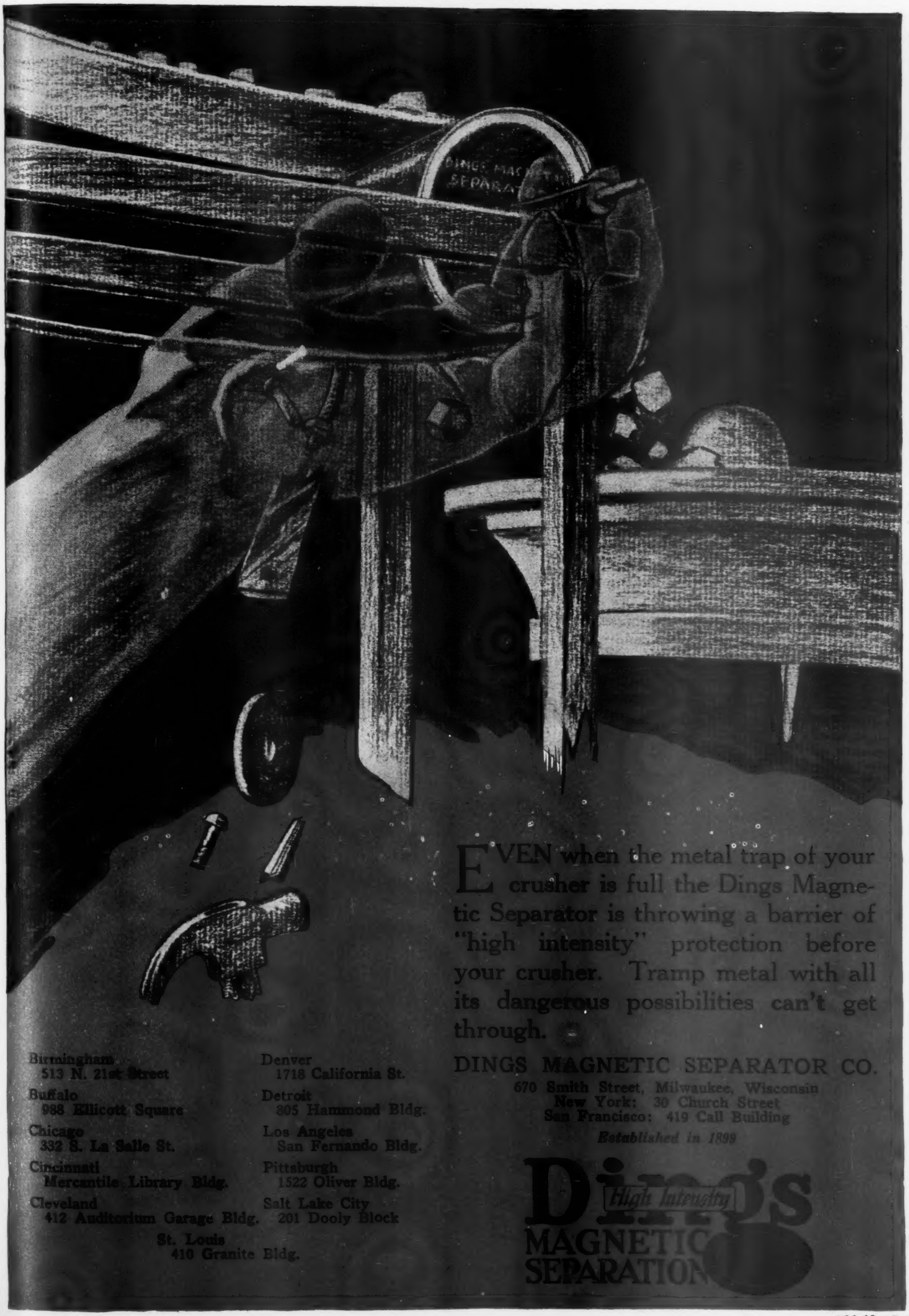
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